AD-A060 355 WOODS HOLE OCEANOGRAPHIC INSTITUTION MASS F/G 8/3
A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATION--ETC(U)
MAR 78 S TARBELL, A SPENCER N00014-66-C-0241
UNCLASSIFIED WHOI-78-5 NL

1 OF 1
AD
A0 60355

END
DATE
FILMED
1-79
DDC

Woods Hole Oceanographic Institution

LEVEL

A COMPILATION OF MOORED CURRENT DATA
AND ASSOCIATED OBSERVATIONS
(MODE-SITE, VOL. XVI 1971-1975)

by

Susan Tarbell
and
Ann Spencer

March 1978

TECHNICAL REPORT

Prepared for the Office of Naval Research under Contracts N00014-66-C-0241; NR 083-004; N00014-74-C-0262; NR 083-004; and N00014-76-C-0197; NR 083-400 and for the National Science Foundation, Office for the International Decade of Ocean Exploration under Grants GX-29054 and OCE75-03962.

Approved for public release; distribution unlimited.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: WHOI-78-5	2. GOVT ACCESSION NO. Volume XVI.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975),		5. TYPE OF REPORT & PERIOD COVERED: Technical rept.,
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Susan Tarbell ~~and~~ Ann Spencer		8. CONTRACT OR GRANT NUMBER(s): N00014-66-C-0241; GX-29054 N00014-74-C-0262; N00014-76-C-0197; OCE75-03962
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Woods Hole Oceanographic Institution Woods Hole, MA 02543		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NR 083-004 NR 083-400
11. CONTROLLING OFFICE NAME AND ADDRESS: NORDA National Space Technology Laboratory Bay St. Louis, MS 39529		12. REPORT DATE: March 1978
		13. NUMBER OF PAGES: 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 56p.		15. SECURITY CLASS. (of this report): Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DDC JUN 22 1978 F

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

1. Moorings
2. Ocean Currents
3. Ocean Temperature

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful (Cont. on back)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE UNCLASSIFIED 3/78

S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

381 000

78 06 20 006

CONT

spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

WHOI-78-5

A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975)

By

Susan Tarbell and Ann Spencer

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

March 1978

TECHNICAL REPORT

Prepared for the Office of Naval Research under Contract Numbers N00014-66-C-0241, NR 083-004; N00014-74-C-0262, NR 083-004; and N00014-76-C-0197, NR 083-400 and the National Science Foundation, Office for the International Decade of Ocean Exploration, Grant Numbers GX 29054 and OCE75-03962.

Approved for Distribution

L. Valentine Worthington, Chairman
Department of Physical Oceanography

ABSTRACT

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

PREFACE

This volume is the sixteenth of a series of data reports presenting moored current meter and associated data collected by the W.H.O.I. Buoy Group.

Volumes I through XV present data from the years 1963-1971, and from several special experiments: the 1970 Pollard array, the 1973 IWEX array, the 1973 MODE array, and the Saint Croix mooring measurements.

Volume XVI presents MODE region data from 1971 through 1975.

Volume Number	W.H.O.I. Ref. #		Notes year	experiment
I	65-44	Webster, F., and N. P. Fofonoff		
II	66-60	Webster, F., and N. P. Fofonoff		
III	67-66	Webster, F., and N. P. Fofonoff		
IV	70-40	Pollard, R. T.		
V	71-50	Tarbell, S., and F. Webster	1966	measurements
VI	74-4	Tarbell, S.	1967	measurements
VII	74-52	Chausse, D., and S. Tarbell	1968	measurements
VIII	75-7	Pollard, R. T., and S. Tarbell	1970	Array data
IX	75-68	Tarbell, S., M. G. Briscoe, and D. Chausse	1973	IWEX Array
X	76-40	Tarbell, S.	1969a	measurements
XI	76-41	Tarbell, S.	1969b	measurements
XII	76-101	Chausse, D., and S. Tarbell	1973	MODE Array
XIII	77-18	Tarbell, S., and A. W. Whitlatch	1970	measurements
XIV	77-41	Tarbell, S., R. Payne, and R. Walden	1976	Mooring 592, Saint Croix
XV	77-56	Tarbell, S., and A. W. Whitlatch	1971	measurements

A045 525

INDEX

INDEX (con't.)

ACKNOWLEDGMENTS

Data return from moored instruments improved markedly over the years covered in this report. Acknowledgments should go to the buoy engineers and operations personnel who solved numerous problems and introduced many innovative techniques. Together with the crews of the R/V Chain, the R/V Knorr and the R/V Atlantis II, they developed increasingly more reliable procedures for mooring deployment and recovery.

The current meter data in this report were processed with the help of all members of the data processing group under the guidance of the scientific staff. The CTD data were processed by N. Pennington and prepared for publication by C. Mills.

The following agencies are acknowledged for their support of the experiments and data preparation which form the basis of this report: the National Science Foundation (IDOE contract numbers GX29054, OCE 75-03962) and the Office of Naval Research (contract numbers N00014-66-C0241 NR083-004, N00014-74-C0262 NR083-004

Presentation

This report is shown in its entirety on microfiche with a summary presented on printed pages for easier access. The summary gives a general description of the MODE area moorings, some details of the instrumentation used in acquiring the data and a description of the computer display programs. It also contains composite plots of filtered current, temperature and pressure data.

The first page of microfiche contains the summary and selected CTD plots. The CTD plots are shown only on microfiche. The seven rows of the first microfiche page are organized as follows:

Row A Text

Row B Text

Row C Composite plots by mooring location

Row D Composite horizontal array plots

Row E Composite temperatures from T/Ps

Row F Composite pressures from T/Ps

Row G Plots of temperature and salinity from CTD lowerings

The basic current meter displays are organized on subsequent microfiche sheets so that the displays for an individual instrument are arranged down a microfiche column, and similar plots for different instruments are arranged across the rows.

The seven rows of data displays on microfiche are as follows:

Row A Mooring diagrams

Row B Data identifier

Row C Instrument information and computed statistical quantities

Row D Spectral diagrams

Row E Progressive vector plots

Fow F u and v plotted against time

Row G Speed, direction (and temperature if available) plotted against time

On microfiche #6, the last 3 columns have a different format due to the length of the time series.

No data are presented for the various tensiometers and inclinometers set on some moorings, nor for experimental depth or temperature recorders.

Introduction

The data presented in this report are from the MODE region here defined to be a circular area of about 1000 square kilometers centered on 28°N, 69° 40'W (see Fig. 1). The records span 3½ years from 1971 to 1975.

The first array (MODE-0, Array 1) consisted of two surface and five intermediate moorings located around and to the west of MODE-Center, (28°N, 69° 40'W) where the bottom topography was smooth. The second array consisted of four intermediate, 1 surface and a deep mooring, located east of MODE-Center where the bottom topography was rough. The third array was more widely spaced, and consisted of four surface moorings, one with a wind recorder, and one intermediate mooring. The fourth array consisted of two intermediate moorings at MODE-Center and MODE-East (28°N, 68° 40'W). The fifth array (Chausse, Tarbell, 1976) was set as part of the MODE-I experiment.

The arrays set after MODE-I are referred to as site moorings. Their locations were at MODE-Center (28°N, 69° 40'W) and MODE-East (28°N, 68° 40'W) and intermediate moorings were used throughout.

Details of mooring locations and durations at sea are presented in Figures 1, 2 and Table 1.

The first three MODE-0 arrays were deployed to find an optimum design for the MODE-I experiment (Heinmiller, 1975). They were in different locations, of different spatial density and of different mooring types. The fourth array and the post-MODE site moorings were deployed to obtain long-term records for study of low frequency phenomenon (Schmitz, 1977). Mooring 542 was set as part of a subsequent experiment and was also a continuation of the moorings set at MODE-Center. It is included in this report to show the full extent of the data gathered at that location.

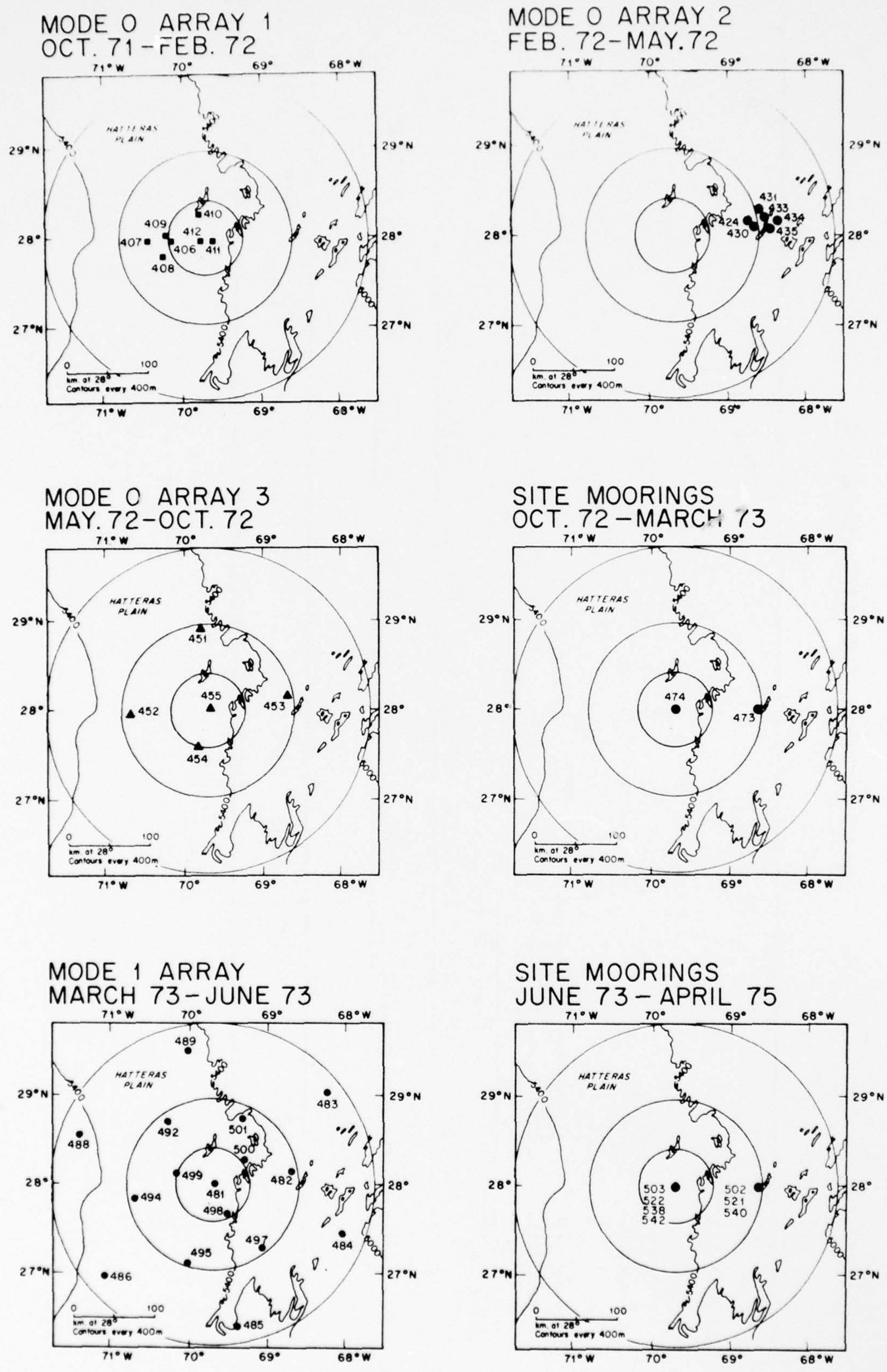


FIGURE 1 MOORING POSITIONS

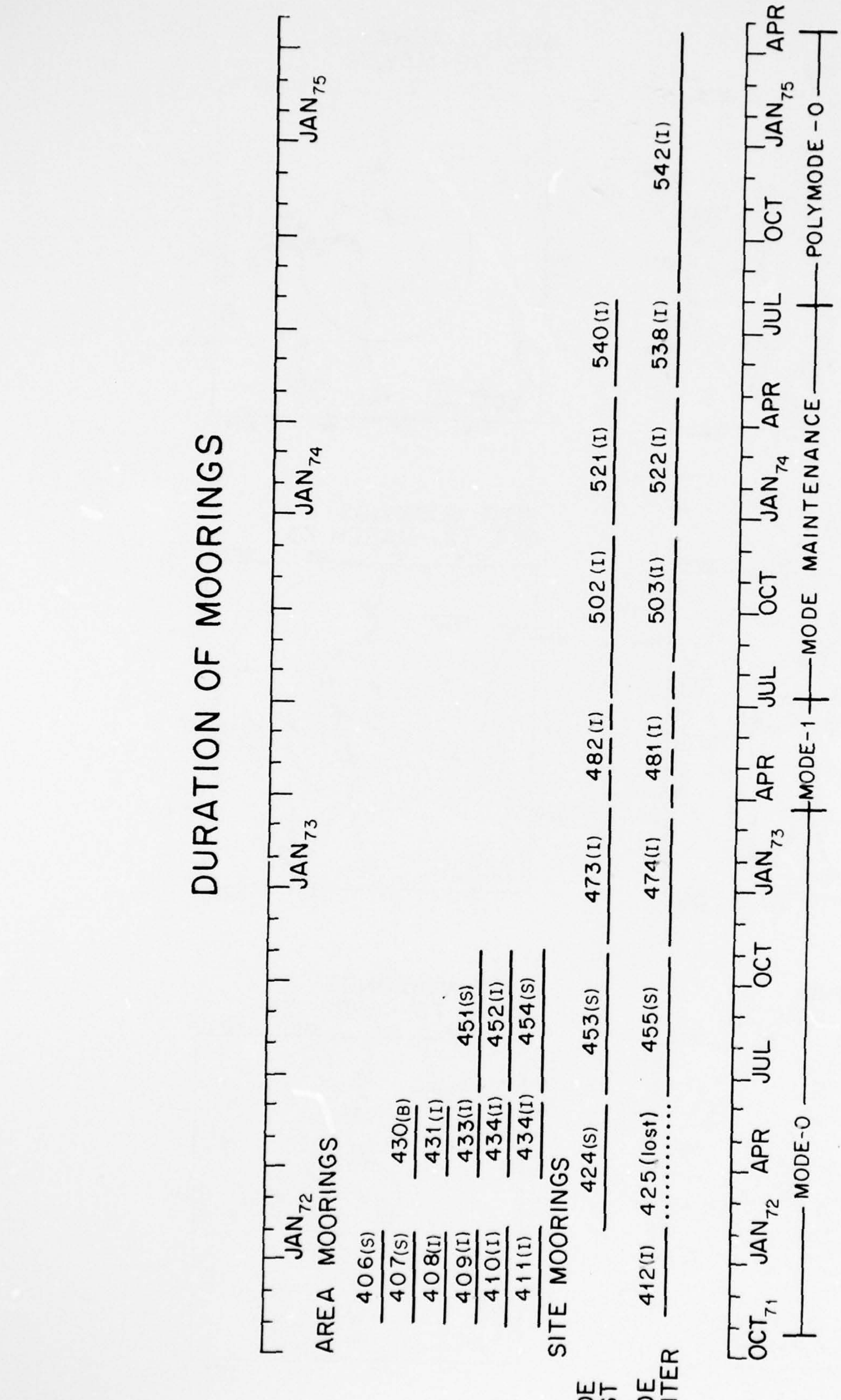

DURATION OF MOORINGS
JAN72
JAN73
JAN74
JAN75
AREA MOORINGS
406(S)
407(S)
408(I)
409(I)
410(I)
411(I)
430(B)
431(I)
433(I)
434(I)
434(I)
451(S)
452(I)
454(S)
SITE MOORINGS
MODE EAST
424(S)
453(S)
473(I)
482(I)
502(I)
521(I)
540(I)
MODE CENTER
412(I)
425(lost)
455(S)
474(I)
481(I)
503(I)
522(I)
538(I)
542(I)
OCT71 JAN72 APR JUL OCT JAN73 APR JUL OCT JAN74 APR JUL OCT JAN75 APR
MODE-0
MODE-1
MODE MAINTENANCE
POLYMODE-0

FIGURE 2

Table 1

Summary of MODE 0 and MODE Site Moorings

Mooring Number	Type* S	I	IW	B	Location (lat. N.,	long. W)	Bottom Depth (m)	Set, Retrieval Dates
Array 1								
406	S				27°59.8'	70° 0.3'	5460	Oct. 29'71-Feb. 7'72
407	S				28° 0.4'	70°20.6'	5465	Oct. 30'71-Feb. 9'72
408		I			27°49.0'	70° 8.8'	5470	Oct. 30'71-Feb. 9'72
409		I			28° 1.5'	70° 6.8'	5465	Oct. 30'71-Feb. 9'72
410		I			28°21.5'	69°41.5'	5460	Oct. 31'71-Feb. 9'72
411		I			28° 0.7'	69°31.3'	5427	Oct. 31'71-Feb. 7'72
412		I			28° 0.2'	69°41.5'	5455	Oct. 31'71-Feb. 7'72
Array 2								
424	S				28° 9.1	68°36.8'	5254	Feb. 6'72-May 25'72
425	S				28° 0.8'	69°39.8'	5462	Feb. 8'72-Lost-
430				B	28° 9.8'	68°34.5'	5221	Mar. 18'72-May 25'72
431		I			28°20.3'	68°24.8'	5370	Mar. 19'72-May 26'72
432		I			28°10.5'	68°23.8'	5380	Mar. 20'72-Aborted
433		I			28°10.5'	68°23.8'	5380	Mar. 20'72-May 27'72
434		I			28°10.2'	68°11.8'	5275	Mar. 20'72-May 26'72
435		I			27°58.7'	68°24.7'	5280	Mar. 21'72-May 26'72
Array 3								
451	S				28°54.4'	69°41.0'	5437	May 23'72-Nov. 1'72
452		I			27°59.8'	70°38.7'	5452	May 23'72-Oct. 31'72
453	S				28°10.1'	68°38.2'	5261	May 25'72-Oct. 30'72
454	S				27°33.7'	69°41.8'	5462	May 28'72-Oct. 31'72
455	S				28° 0.6'	69°37.6'	5462	May 28'72-Nov. 4'72
Site Mooring								
473		I			28°10.7'	68°36.1'	5261	Oct.30'72-Mar. 11'73
474		I			28° 1.4'	69°39.4'	5462	Nov. 4'72-Mar. 10'73
Site Mooring								
502		I			28° 8.9'	68°41.4'	5255	June 26'73-Dec 13'73
503		I			28° 0.2'	69°44.4'	5461	June 27'73-Dec 14'73
521		I			28° 9.5'	68°41.5'	5265	Dec. 13'73-Apr 20'74
522		I			28° 0.5'	69°44.8'	5462	Dec. 14'73-Apr 21'74
538			IW		28° 2.6'	69°44.8'	5457	Apr. 18'74-Jul 27'74
540		I			28° 8.9'	68°40.4'	5265	Apr. 20'74-Jul 29'74
542			IW		28° 1.4'	69°38.9'	5462	July 27'74-Apr 26'75

* S = Surface compound mooring

I = Intermediate compound mooring

IW = Intermediate all wire mooring

B = Bottom mooring

Moorings

Both surface and intermediate moorings were set in the early 1970s. (See Table 1.) Growing evidence that current meter data were contaminated by noise from surface waves propagating down the mooring line led to the increasing use of intermediate moorings. The compound intermediate mooring (Heinmiller, 1976) proved extremely reliable with only 3 failures in 103 moorings. In the MODE-1 experiment there were large discrepancies between the intended and actual instrument depths (Chausse and Tarbell, 1976), which were due in part to the unpredictable stretch factor of the Dacron line. In 1974, the first all-wire intermediate moorings (538, 542) were set in an effort to maintain the instrumentation at its intended depth.

Numerous minor improvements were made over the years to increase the reliability of various mooring components. For instance, glass spheres were placed in plastic hard hats instead of nets to reduce the risk of an implosion severing the mooring line. Such changes enabled moorings to be set with confidence for 9 months or longer as scientific necessity dictated.

For greater detail about MODE area moorings, see Heinmiller (1975), Heinmiller (1976) and Berteaux and Heinmiller (1973).

Current Meter Types

The current meters described in this report were either Vector Averaging Current Meters (VACMs), built by American Machine and Foundry (AMF) or Model 850 current meters built by Geodyne, now a part of Egerton, Germeshausen and Grier (EG&G).

The Model 850 current meter stores burst sampled data on magnetic tape cartridges. Each Model 850 collected and stored 23 (or 24) data cycles which were sampled every 5.27 seconds. The instrument then turned off for the remainder of the recording interval, usually either 15 or 30 minutes. Those Model 850s which were modified to include temperature measurements accumulated the count from the temperature circuit from one 5.19 second period and stored it at the beginning of each data burst.

The VACM stores variables on 1/8" magnetic tape cassettes at the end of each recording interval, typically every 30 minutes. Values in the East and North register are computed from compass, vane and rotor values each time a rotor magnet passes the sensing diode. The velocity components are accumulated over the recording interval resulting in vector averaged velocities. The temperature count is summed from the pulses of a voltage to frequency converter, whose output frequency is relayed to the thermistor resistance at its input (Payne et al., 1976).

Temperature/Pressure Recorder

An instrument to measure and store temperature, pressure and time data (T/P) was developed in the Draper Laboratory at M.I.T. for the MODE-1 Data Array, and used extensively on the post-MODE moorings. The instrument stores a data sample every 15 seconds and records the sum of 64 successive data samples on a magnetic tape cassette every 16 minutes ($64 \times 15 = 960$ seconds = 16 minutes).

The time base generator, a crystal oscillator, has an accuracy of ±1 second per day.

The temperature has an accuracy of about .01°C and a resolution of .001°C (Wunsch and Dahlen, 1974).

The pressure sensor is a strain gauge with a manufacturer specified accuracy of .03% of the scale range used (Wunsch and Dahlen, 1974).

CTD

The CTDs were constructed at W.H.O.I. by Neil Brown (Brown, 1974; Fofonoff, Hayes and Millard, 1975; Brown and Morrison, 1978). The instruments measure conductivity, temperature and pressure. Plots of potential temperature and salinity versus pressure are included on the first page of microfiche.

Time

A time base for the T/Ps, 850s and VACMs is set by a quartz crystal oscillator with a manufacturer's specified accuracy of ±1 second per day.

To provide secondary time information for current meter records, artificial events are placed in the rotor field both before and after the sea data. The procedure for this is as follows:

For First Events:

Step 1.	Turn the recording circuit on (not to be turned off until recovery).
Step 2.	a) Block the rotor to prevent it from turning. b) Allow the instrument to record several data cycles with the rotor immobilized.
Step 3. (t)	Ten seconds after a recording interval starts, spin the rotor as fast as possible.
Step 4. (t)	In a successive record spin the rotor again.
Step 5.	Block rotor again until just before launch.
Step 6. (t)	Free the rotor at launch.

For Last Events:

Step 1. (t)	After recovery, block rotor for several recording intervals.
Step 2. (t)	Ten seconds after a recording interval starts, spin the rotor.
Step 3. (t)	Spin the rotor again in a subsequent record.
Step 4.	Block the rotor for several records before shutting off the record circuit.

The steps that are marked with a (t) are the most easily seen in the data and times should be noted using a radio time signal e.g., WWV or CHU.

Under normal operating conditions the elapsed time measured by the clock word matches the real elapsed time.

In this report time is read as year-month-day hour.minute.second.

Current Meter Data Processing

Bit strings from magnetic tapes for Model 850s (1/4" 2-track cartridges) and VACMs (1/8" 4-track cassettes) were transcribed onto 9-track computer compatible tape at W.H.O.I. The data were then converted to scientific units (decoded) and stored on magnetic tape in Maltais format (Maltais, 1969).

Editing the data included selecting times for the beginning and ending of each record, adjusting the nominal depth of some records to agree with information supplied by the T/Ps, applying corrections to temperature indicated by post cruise thermistor calibrations, computing vector averaged components for the data from burst sampled Model 850 instruments, and interpolating through gaps in the data caused by the removal of erroneous records.

The result is an evenly spaced time series which is used as a basic input for all further processing.

The current data were classified into three categories (good, questionable and bad). "Good" is defined to mean that all sensors worked properly. "Questionable" means that the data has a known problem which might not affect the low frequency data, e.g., 5032. "Bad" means that at least one of the sensors did not work at all. The individual data series presented in this report contain mostly "Good" and some "Questionable" data. Questionable data is indicated on the Instrument page (row C on the microfiche pages presenting data).

Table 2 indicates which variables are presented with reference to mooring numbers and approximate depths.

Data Identifiers

To insure that each data series has a unique identifier, the following guide lines are used; 538,10B900

538	-	The first three digits are the mooring number
,10	-	The 10th instrument down the mooring line. A one digit mooring position is not preceded by a comma (5385D900).
B	-	The position of the letter in the alphabet indicates the amount of editing that has been done. The symbol $ means no editing has been done.
900	-	Vector averaging interval (in seconds). 1H would mean 1 hour averages, 1D for 1 day averages.
1DGAU24	-	A 1 day averaged series from Gaussian filtered data, the filter having a half width of 24 hours.

Table 3, which has the same format as Table 2 indicates the position number, depth and type of each instrument which has data in this report.

Pre MODE Data Series - MODE 0

	Array 1							Array 2						Array 3				
	406	407	408	409	410	411	412	424	430	431	433	434	435	451	452	453	454	455
0																	V	
500	V	V												VT	VT	VT		VT
800	V																	
1500	VT	VT	V	VT	V	V	VT	VT								VT		VT
1600	V																	
4000	V	V		V	V			VT	VT	V	V	V	T			PT T		
4200	V													V	V		V	V
5000+								VT	V									

Post MODE Data Series - Site Moorings

	473	474	502	503	521	522	538	540	542
500	V	V	V	V	V	V	VT	V	VT
600					TP	TP	TP	TP	
800					TP		TP	TP	TP
1000					TP		TP	TP	TP
1500	V	V	V	V	V	V	VT	V	VT
2000					TP	TP	TP	TP	
2500					TP	TP	TP	TP	
3500					TP	TP	TP		TP
4000	V	V	V		V TP	V TP	VT TP	V	V TP
4500					TP	TP	TP	TP	
5000+					TP	TP	TP		

TABLE 2 VARIABLES PRESENTED V=VELOCITIES
T=TEMPERATURES
P=PRESSURE

Instrument Depth and Data Identifier Summary

Pre MODE - MODE 0

	Array 1							Array 2						Array 3				
Meters	406	407	408	409	410	411	412	424	430	431	433	434	435	451	452	453	454	455
0																	0 (1)	
500	514 (3)	514 (1)												515 (2)	561 (2)	514 (2)		514 (2)
800	816 (4)																	
1500	1518 (5)	1516 (2)	1503 (1)	1522 (1)	1504 (1)	1476 (1)	1502 (1)	1519 (2)								1516 (3)		1516 (3)
1600	1620 (6)																	
4000	4003 (7)	4001 (3)		4028 (2)	4008 (2)			4074 (3)	3975 (1)	3955 (2)	3990 (2)	3970 (2)	3968 (4)			3970 -5- 4075 (6)		
4200	4202 (8)													4191 (3)	4181 (6)		4207 (4)	4208 (4)
5000+								5131 (4)	5119 (2)									
Water Depth (m)	5460	5465	5470	5465	5460	5427	5455	5254	5221	5370	5380	5275	5280	5437	5452	5261	5462	5462

Post MODE - Site Moorings

	473	474	502	503	521	522	538	540	542
500	370 (2)	583 (2)	516 (1)	494 (1)	508 (1)	491 (1)	511 (1)	509 (1)	495 (1)
600					605 -2-	592 -2-	612 -2-	610 -2-	
800					802 -3-		809 -3-	807 -3-	796 -2-
1000					999 -4-		1006 -4-	1004 -4-	996 -3-
1500	1385 (4)	1595 (3)	1524 (2)	1501 (2)	1506 (5)	1497 (5)	1500 (5)	1511 (5)	1499 (4)
2000					2007 -6-	1998 -6-	2001 -6-	2012 -6-	
2500					2509 -7-	2495 -7-	2508 -7-	2512 -7-	
3500					3510 -8-	3497 -8-	3509 -8-		3499 -6-
4000	3900 (5)	4105 (4)	4015 (3)		4011 (9)	3998 (9)	3998 (9)	4008 (9)	4000 (7)
					4014 -10-	4001 -10-	4001 -10-		4003 -8-
4500					4414 -11-	4402 -11-	4394 -11-	4409 -11-	
5000+					5166 -12	5361 -12-	5355 -12-		
Water Depth (m)	5261	5462	5255	5461	5265	5462	5457	5265	5462

TABLE 3 DEPTHS OF INDIVIDUAL INSTRUMENTS IN METERS
INSTRUMENT POSITION NUMBER AND INSTRUMENT TYPE; (N) for CM, -N- for T/P

Computer Programs

The following programs have been used to generate the data displays in this report:

Statistics (STATS)

Standard statistical parameters are calculated for data in the time range given at the bottom of the table. Given n speed and direction or temperature values in a sample, we define $E_i = S_i \sin\Theta_i$, $N_i = S_i \cos\Theta_i$, then for $A = E, N, S,$ and T,

$$\text{mean, } \bar{A} = \frac{1}{n}\sum_{i=1}^{n} A_i \qquad \text{variance, } \sigma_A^2 = \frac{1}{n}\sum_{i=1}^{n} A_i^2 - \bar{A}^2$$

$$\text{standard error of the mean} = \frac{\sigma_A}{\sqrt{n}} \qquad \text{standard deviation} = \sigma_A$$

$$\text{skewness} = \frac{1}{\sigma_A^3}\left[\frac{1}{n}\sum_{i=1}^{n} A_i^3 - \frac{3\bar{A}}{n}\sum_{i=1}^{n} A_i^2 + 2\bar{A}^3\right]$$

$$\text{kurtosis} = \frac{1}{\sigma_A^4}\left[\frac{1}{n}\sum_{i=1}^{n} A_i^4 - \frac{4\bar{A}}{n}\sum_{i=1}^{n} A_i^3 + \frac{6\bar{A}^2}{n}\sum_{i=1}^{n} A_i^2 - 3\bar{A}^4\right]$$

Note that the kurtosis becomes unstable for sufficiently narrow distributions (see record 521,12).

The program also calculates "East and North" statistics,

$$\text{covariance, } M = \frac{1}{n}\sum_{i=1}^{n} E_i N_i - \bar{E}\,\bar{N}$$

$$\text{standard deviation of covariance, } \sigma_m = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (E_i N_i)^2 - \overline{E\,N}^2}$$

$$\text{standard error of covariance} = \frac{\sigma_m}{\sqrt{n}}$$

correlation coefficient, $M' = \frac{M}{\sigma_E \sigma_M}$.

The program also calculates parameters related to vector quantities: the scalar amplitude of the vector mean, $V_m = \sqrt{\bar{E}^2 + \bar{N}^2}$; vector variance $V_v = \frac{1}{2}(\sigma_E^2 + \sigma_N^2)$; standard deviation $= \sqrt{V_v}$.

Progressive Vector Diagram (PROVEC)

The progressive vector displacements are plotted. The plot begins with an asterisk (*) on a day boundary. All following interval boundaries are indicated by a symbol, which changes with each month in the case of longer records. This type of plot accentuates very low frequency events at the expense of higher frequency oscillations.

Variable vs. Time Plot

This is a diagram of any variable plotted as a function of TIME. The plot is generated from the 1-hour averaged series. This type of plot is complementary to the progressive vector diagram since it accentuates higher frequency events such as inertial and tidal oscillations.

Spectra

The program TIMSAN (TIme Series ANalysis) uses the Fast Fourier Transform algorithm of Singleton (1969) and is restricted to data segments of length N points, where N must be an even number which has no prime factor larger than 5, and must be less than 8000 points; data series longer than this must be broken into two or more pieces.

The number of degrees of freedom for the first 40 plotted points is given by $\nu = a\ m\ s$ where m is the number of adjacent frequency bands being averaged as stated in the label, s is the number of independent data pieces being averaged, again as stated in the label, and a should be set equal to 2 for temperature spectra and for Horizontal Kinetic Energy (HKE) spectra for which the EAST and NORTH components seem statistically independent. In the absence of information regarding NORTH-EAST correlation, one should use $a = 2$ to be safe.

The log-log plot is further averaged during plotting so that more and more points are averaged together as frequency increases. This eliminates the bunching together of points at high frequencies, increases the degrees of freedom of the high frequency estimates, and still permits low-frequency resolution. The averaging algorithm is as follows: counting from the left of the plot, the first 40 plotted points represent data that has been averaged as stated in the label; the data for the next 15 plotted points has been averaged over twice as many frequency bands; the next 6 over five times as many, the next 40 over ten times as many, the next 15 over twenty times as many, the next 6 over fifty times as many, the next 40 over 100 times as many and so on. In this way, for example, 7900 data points with no averaging indicated in the label would be plotted as only 176 points, and the last 14 estimates would be averaged over 200 basic frequency bands. The m in the formula $\nu = a\ m\ s$ for degrees of freedom is, in this example, 200 times larger at the highest frequencies than at the lowest frequencies.

For $\nu \geq 30$, the confidence limits for the spectral estimates are given approximately by $(1 - 2/9\nu \pm Z\sqrt{2/9\nu})^3$ where $Z = 1.28375$ for 80% confidence limits, $Z = 1.645$ for 90%, $Z = 1.96$ for 95% and $Z = 2.5757$ for 99%. In the example above, if the HKE spectral plot label had indicated 2 pieces and averaging over 8 adjacent frequency bands then $\nu = 2 \times 2 \times 8 = 32$ for the lowest frequencies (assuming NORTH and EAST components are highly correlated) and $200 \times 32 = 6400$ for the highest frequencies. The 95% confidence intervals (i.e., 95% of the time one would expect the spectral estimates to vary no more than this much) would be (0.57, 1.55) at low frequencies, and (0.97, 1.03) at high frequencies.

For $\nu \leq 30$, one must obtain confidence intervals from Chi-Squared distribution tables in standard statistical references.

Temperature spectra from 850 current meters show aliasing at high frequencies because of the sampling scheme. Speed and direction are burst sampled within each recording interval. These samples are vector averaged to attenuate high frequency aliasing in the current measurement. There is only one 5.19 second temperature sample per recording interval, however. The temperature spectrum for data series shows clearly the resulting high frequency aliasing. In contrast, the VACM averages all variables over the full recording interval, virtually eliminating the problem.

Gaussian Filtered Plots

The basic time series is filtered using a symmetrical running Gaussian filter with a half width of 24 hours. The filtering is sequential and the resultant time series is 48 hours shorter than the input time series (the first and last 24 hours are lost), and the sampling interval is the same. A simple running hat filter is then applied to the series to form a series with one data point per day, the point being the average for each day measured from midnight to midnight.

A) Vector Stick Plots

The filtered velocity vectors are plotted along a time scale. Unless otherwise indicated, the vector orientation is such that north is up. The length of the "stick" is proportional to speed.

B) Line Plots

Pressure and temperature are filtered as described above, and one point per day is plotted along a time scale.

C) Sequential Array Plots

Subsampled filtered velocity vectors or temperature values are plotted to show a spatial array at a particular depth.

References

Berteaux, H. O., and R. H. Heinmiller, 1973. Back-up recovery of Deep-Sea Moorings. W.H.O.I. Ref. 69-7 (unpublished manuscript).

Brown, N., 1974. A Precision CTD Microprofiler. Proceedings IEEE International Conference on Engineering in the Ocean Environment.

Brown, N. L., and G. K. Morrison, 1978. W.H.O.I./Brown Conductivity, Temperature and Depth Microprofiler. W.H.O.I. Ref. 78-23 (in press) (unpublished manuscript)

Chausse, D., and S. Tarbell, 1976. A Compilation of Moored Current Data and Associated Oceanographic Observations, Volume XII (1973 Mid-Ocean Dynamic Experiment (MODE)). W.H.O.I. Ref. 76-101 (unpublished manuscript).

Fofonoff, N. P., S. P. Hayes, and R. C. Millard, Jr., 1974. W.H.O.I./ Brown microprofiler: methods of calibration and data handling. W.H.O.I. Ref. 74-89 (unpublished manuscript).

Heinmiller, R. H., 1975. Mooring Operations of the Woods Hole Buoy Group for the Mid-Ocean Dynamics Experiment. W.H.O.I. Ref. 75-42 (unpublished manuscript).

Heinmiller, R. H., 1976. Woods Hole Buoy Project Moorings — 1960 through 1974. W.H.O.I. Ref. 76-53 (unpublished manuscript).

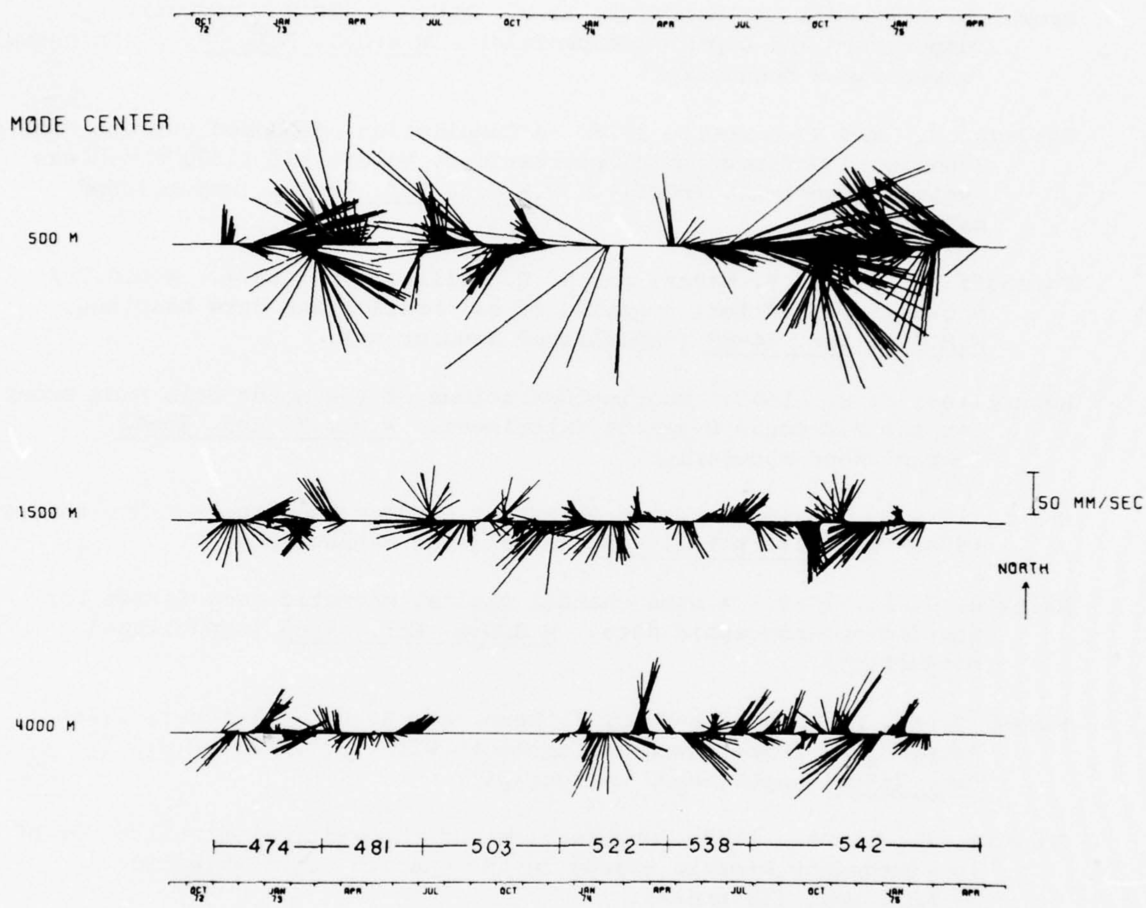
Maltais, J. A., 1969. A nine channel digital magnetic tape format for storing oceanographic data. W.H.O.I. Ref. 69-55 (unpublished manuscript).

Payne, R. E., A. L. Bradshaw, J. P. Dean, and K. E. Schleicher, 1976. Accuracy of temperature measurements with the VACM. W.H.O.I. Ref. 76-94 (unpublished manuscript).

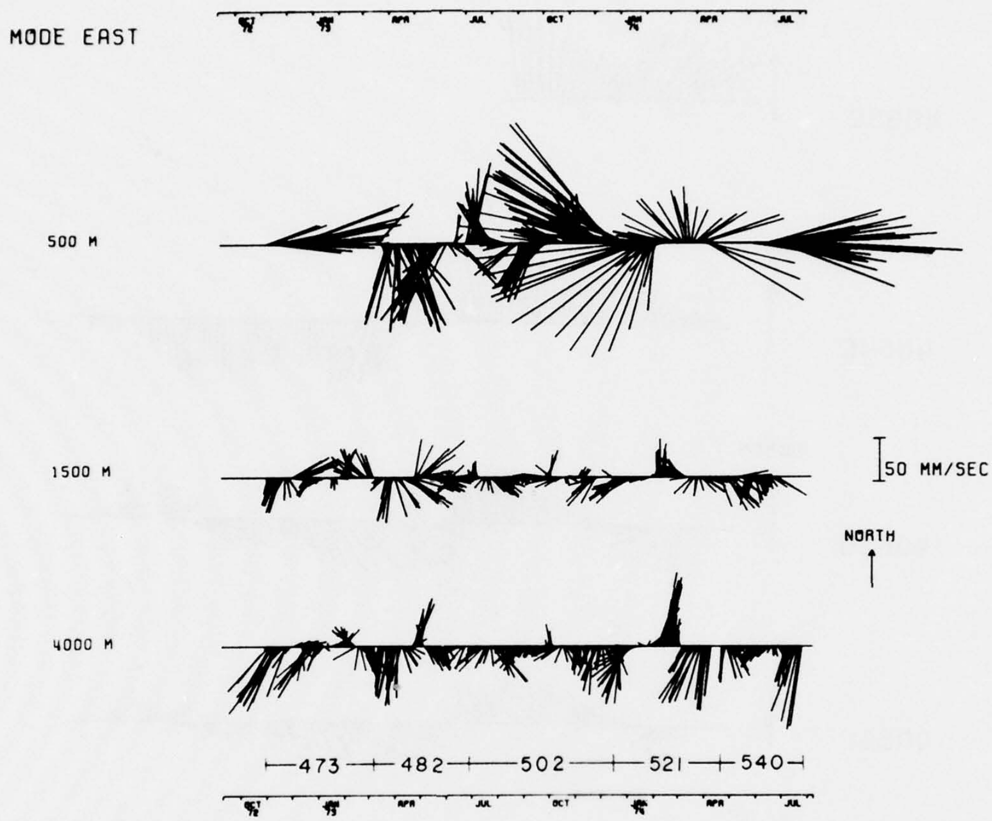
Schmitz, W. J., Jr., 1977. Observations of the vertical distribution of low frequency kinetic energy in the western North Atlantic. J. Mar. Res. (in press).

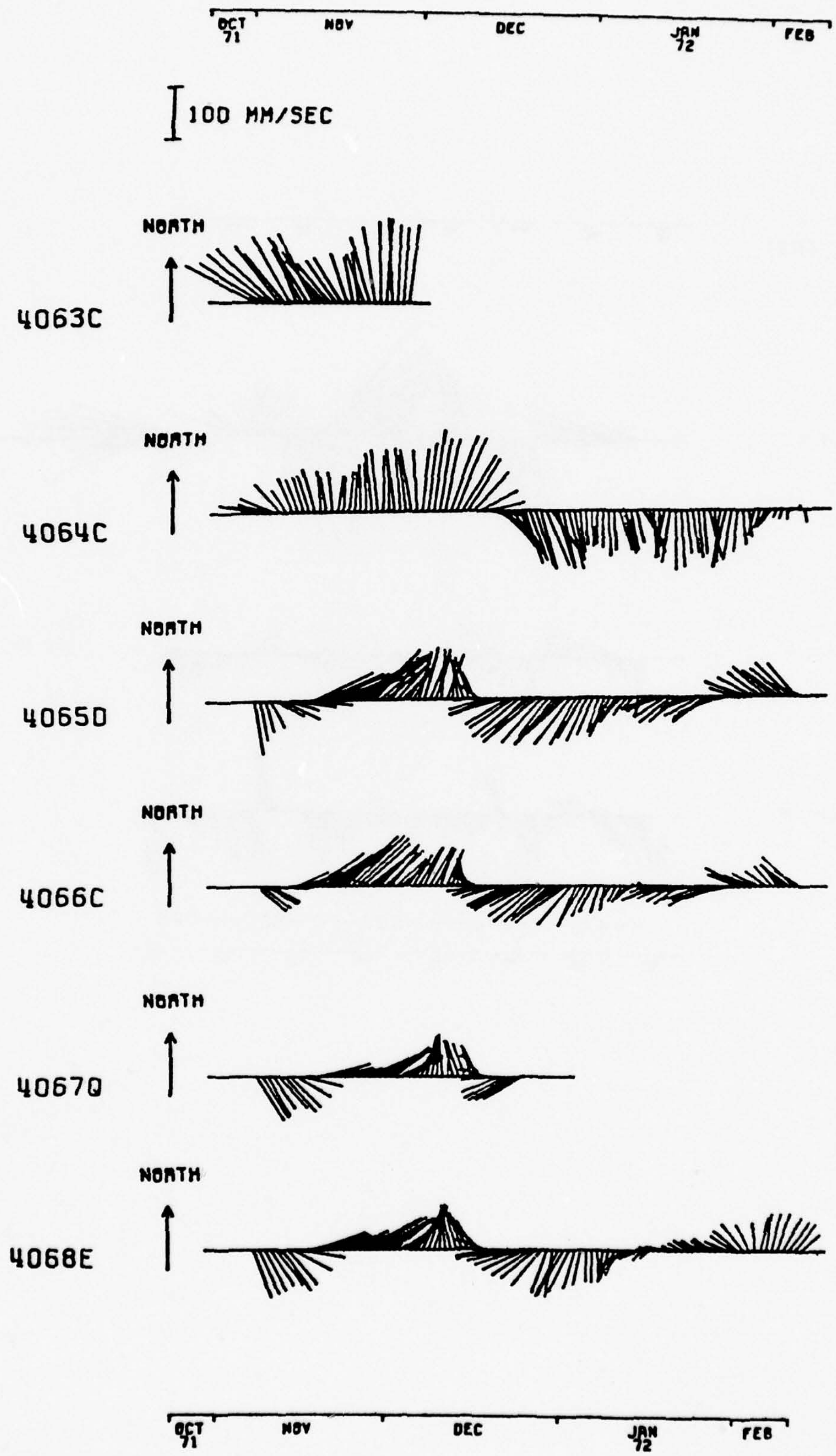
Singleton, R. C., 1969. An algorithm for computing the mixed radix Fast Fourier Transform. I.E.E.E. Trans. on Audio and Electroacoustics, AU-17 (2) 93-103.

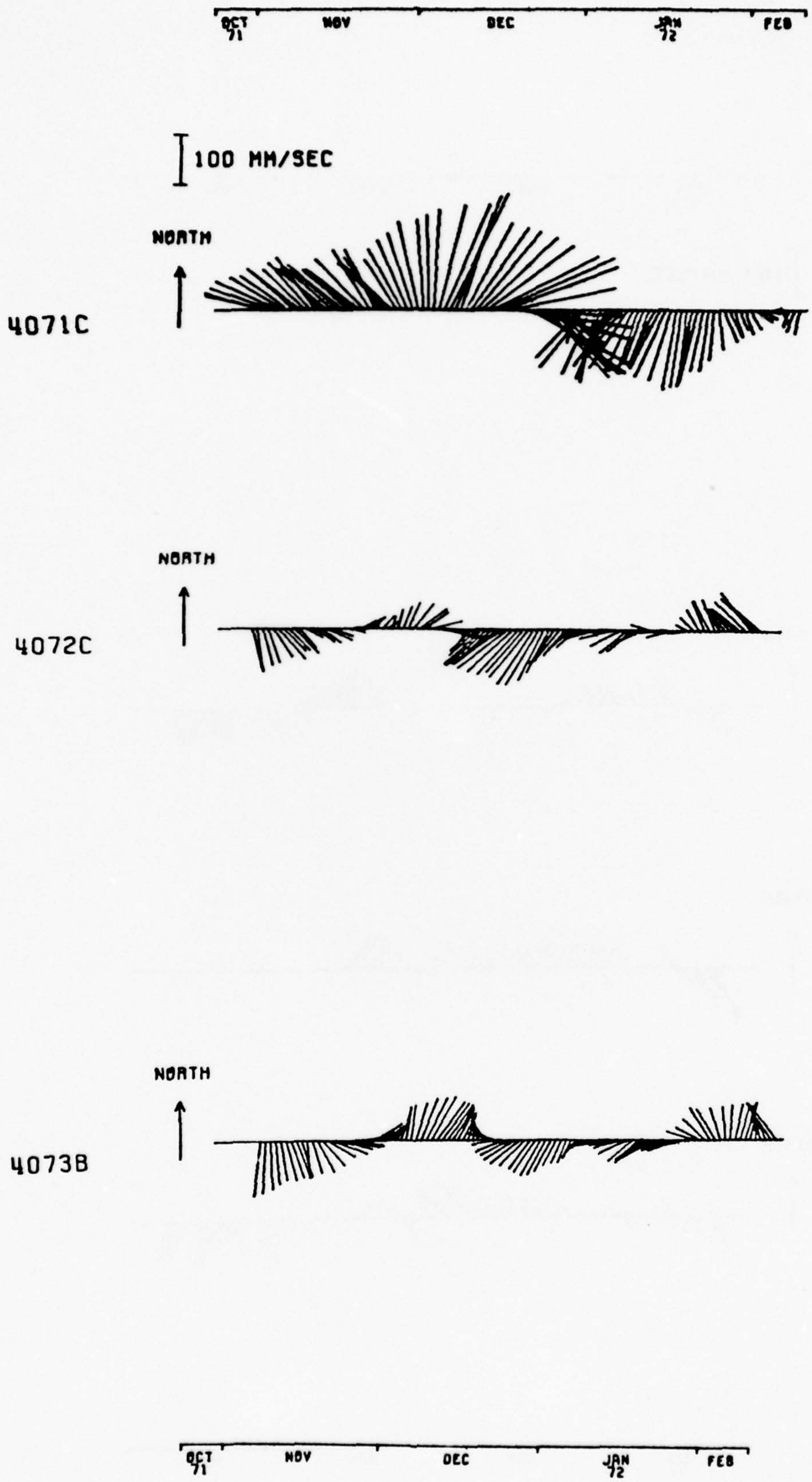
Wunsch, C., and J. Dahlen, 1974. A moored temperature and pressure recorder. Deep-Sea Res., 21, 145-154.

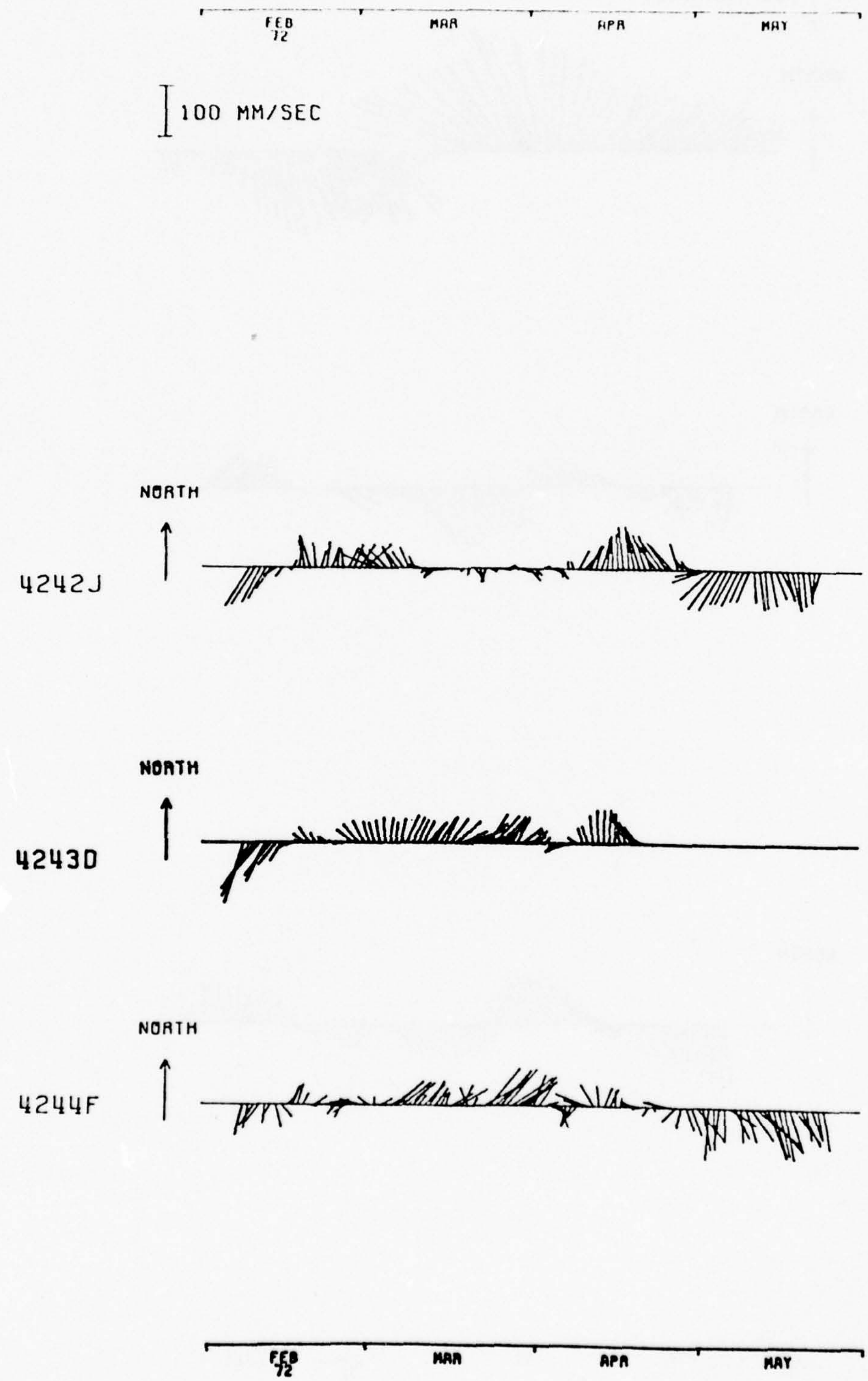


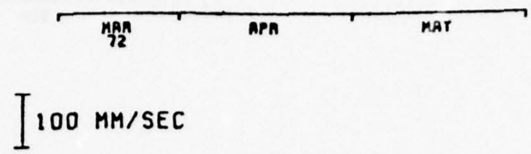
OCT 72
JAN 73
APR
JUL
OCT
JAN 74
APR
JUL
OCT
JAN 75
APR
MODE CENTER
500 M
1500 M
50 MM/SEC
NORTH
4000 M
474
481
503
522
538
542

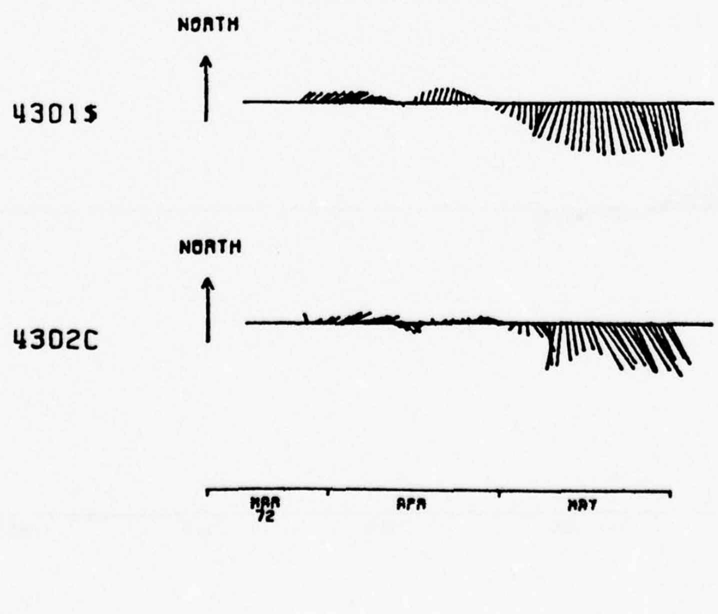

MODE EAST
OCT 72
JAN 73
APR
JUL
OCT
JAN 74
APR
JUL
500 M
1500 M
50 MM/SEC
NORTH
4000 M
473
482
502
521
540

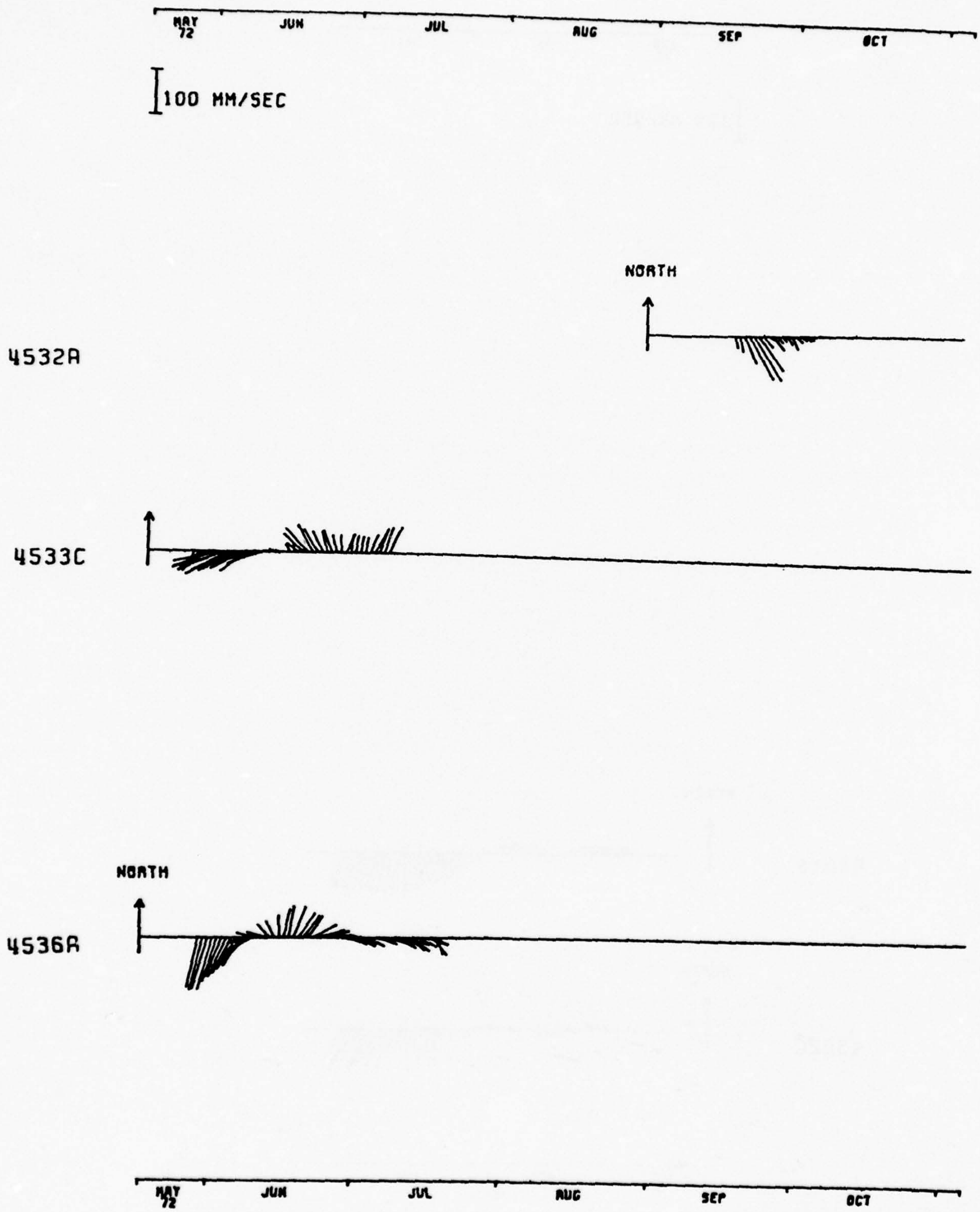

OCT 71
NOV
DEC
JAN 72
FEB
100 MM/SEC
NORTH
4063C
NORTH
4064C
NORTH
4065D
NORTH
4066C
NORTH
4067Q
NORTH
4068E
OCT 71
NOV
DEC
JAN 72
FEB

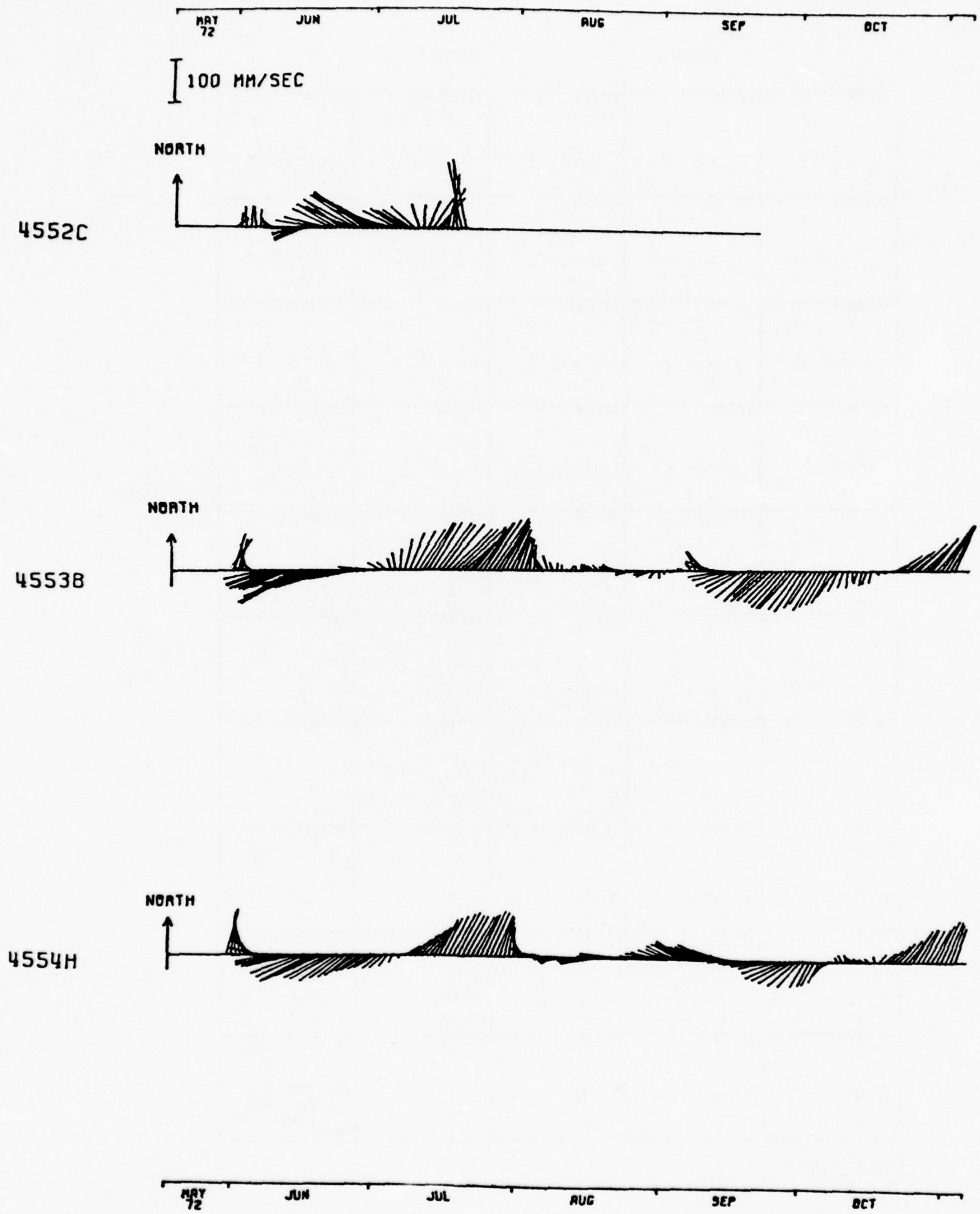

OCT 71
NOV
DEC
JAN 72
FEB
100 MM/SEC
NORTH
4071C
NORTH
4072C
NORTH
4073B
OCT 71
NOV
DEC
JAN 72
FEB


FEB
72
MAR
APR
MAY
100 MM/SEC
NORTH
4242J
NORTH
4243D
NORTH
4244F
FEB
72
MAR
APR
MAY


MAR
72
APR
MAY
100 MM/SEC

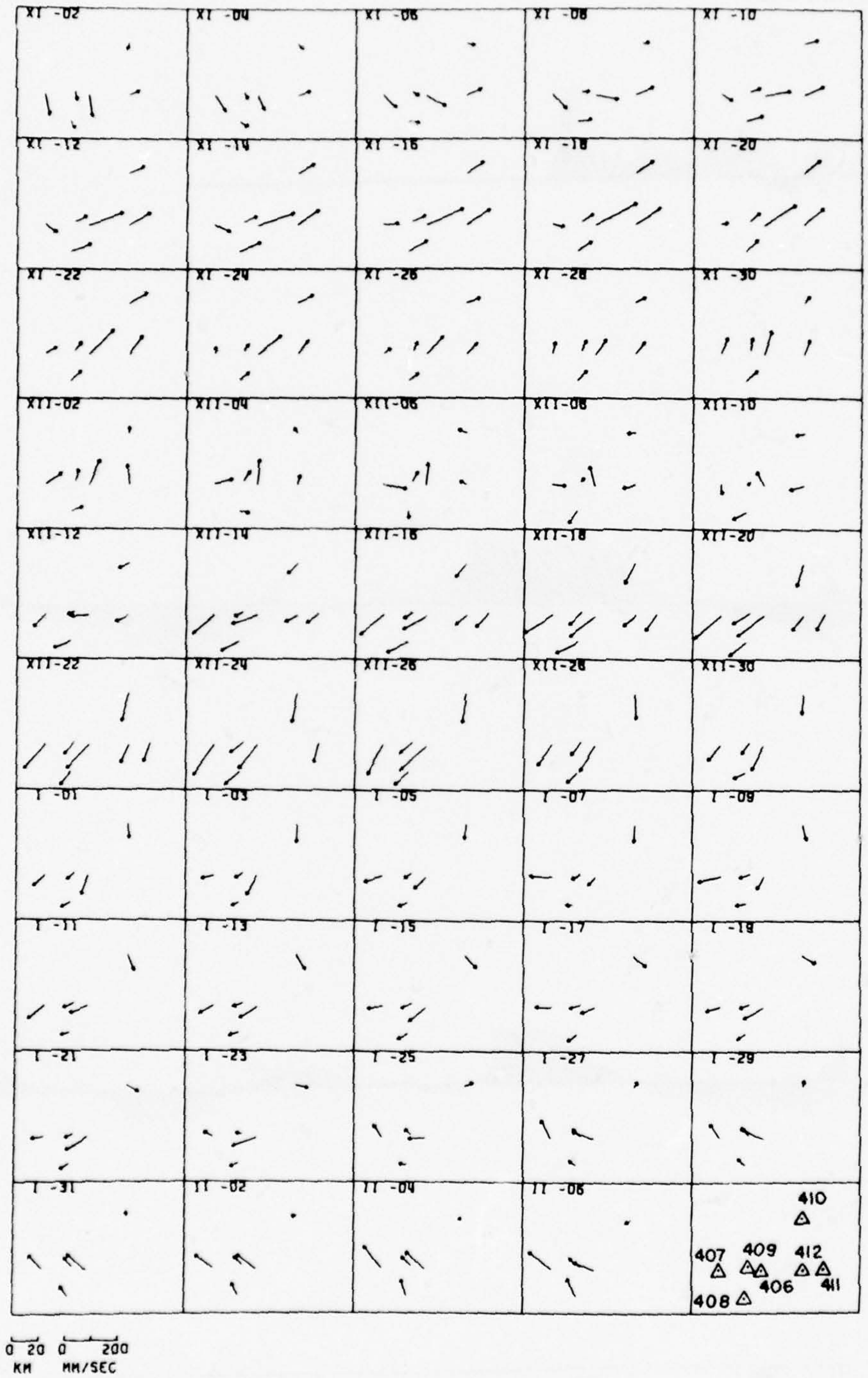

NORTH
4301S
NORTH
4302C
MAR
72
APR
MAY


MAY 72
JUN
JUL
AUG
SEP
OCT
100 MM/SEC
NORTH
4532A
4533C
NORTH
4536A
MAY 72
JUN
JUL
AUG
SEP
OCT



MAY 72
JUN
JUL
AUG
SEP
OCT
100 MM/SEC
NORTH
4552C
NORTH
4553B
NORTH
4554H
MAY 72
JUN
JUL
AUG
SEP
OCT

ARRAY 1 1500 M.



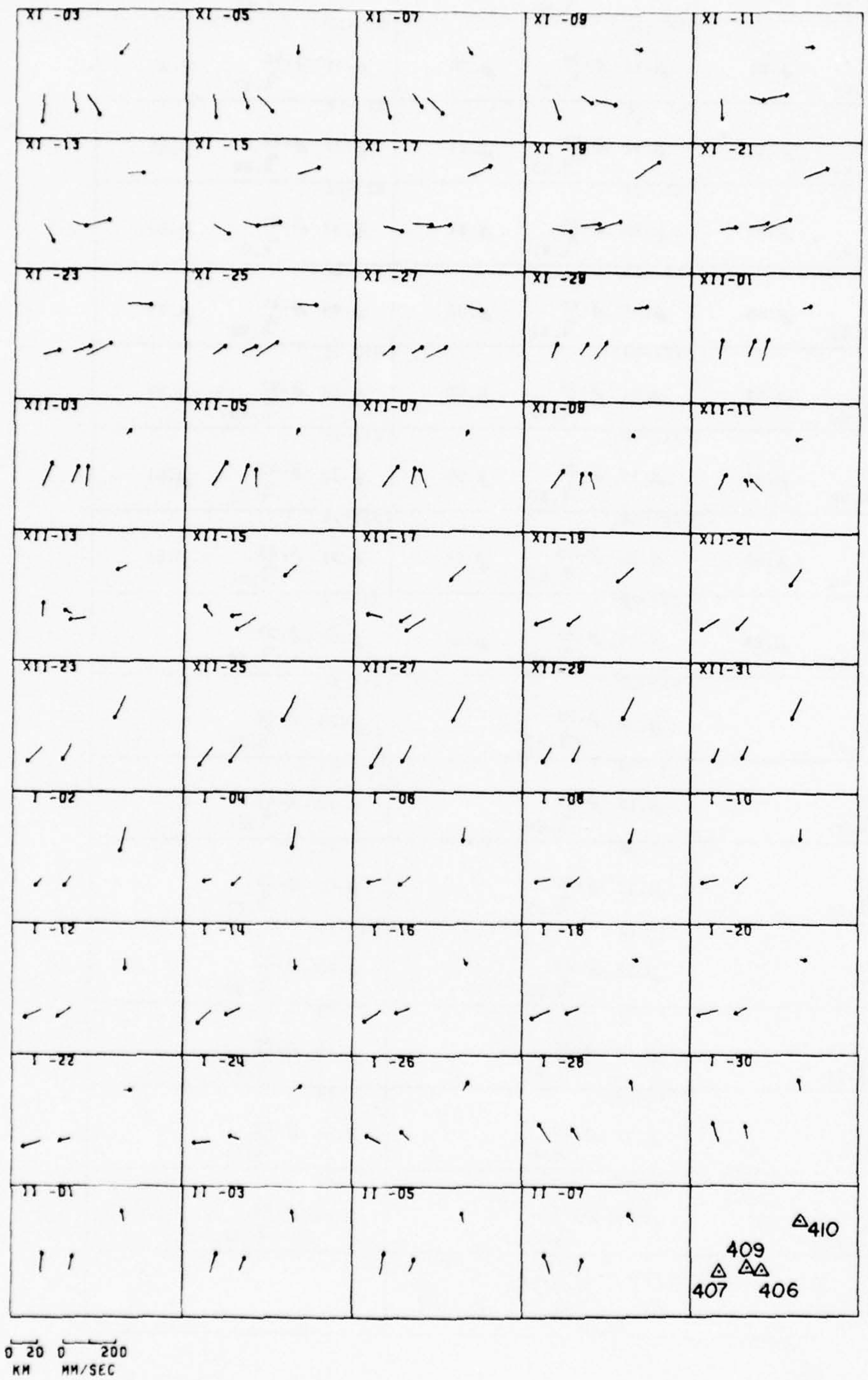
ARRAY 1 1500 M.

XI -02 .30 .46 .62 .48	XI -04 .34 .45 .62 .48	XI -06 .37 .48 .64 .48
XI -08 .36 .45 .64 .46	XI -10 .36 .46 .58 .45	XI -12 .38 .46 .51 .47
XI -14 .38 .46 .46 .44	XI -16 .32 .46 .41 .43	XI -18 .32 .46 .35 .44
XI -20 .30 .48 .33 .42	XI -22 .29 .46 .51 .41	XI -24 .33 .41 .52 .42
XI -26 .32 .42 .58 .43	XI -28 .36 .41 .58 .41	XI -30 .35 .44 .43 .40
XII-02 .35 .41 .48 .42	XII-04 .31 .38 .50 .41	XII-06 .20 .42 .44 .40
XII-08 .18 .44 .51 .43	XII-10 .19 .45 .51 .39	XII-12 .22 .43 .51 .32
XII-14 .31 .38 .50 .40	XII-16 .35 .38 .54 .42	XII-18 .35 .33 .51 .41
XII-20 .31 .28 .46 .35	XII-22 .29 .32 .46 .38	XII-24 .33 .33 .30
XII-26 .27 .28 .27	XII-28 .23 .25 .24	XII-30 .23 .28 .22
I -01 .19 .26 .21	I -03 .18 .26 .24	I -05 .19 .23 .21
I -07 .20 .27 .24	I -09 .20 .24 .25	I -11 .21 .25 .23
I -13 .21 .26 .17	I -15 .22 .23 .20	I -17 .23 .20 .25
I -19 .19 .24 .21	I -21 .19 .24 .21	I -23 .18 .22 .17
I -25 .18 .22 .18	I -27 .21 .23 .21	I -29 .21 .26 .23
I -31 .19 .25 .25	II -02 .22 .27 .24	II -04 .21 .26 .23
II -06 .23 .25 .27	407 406 409 412	

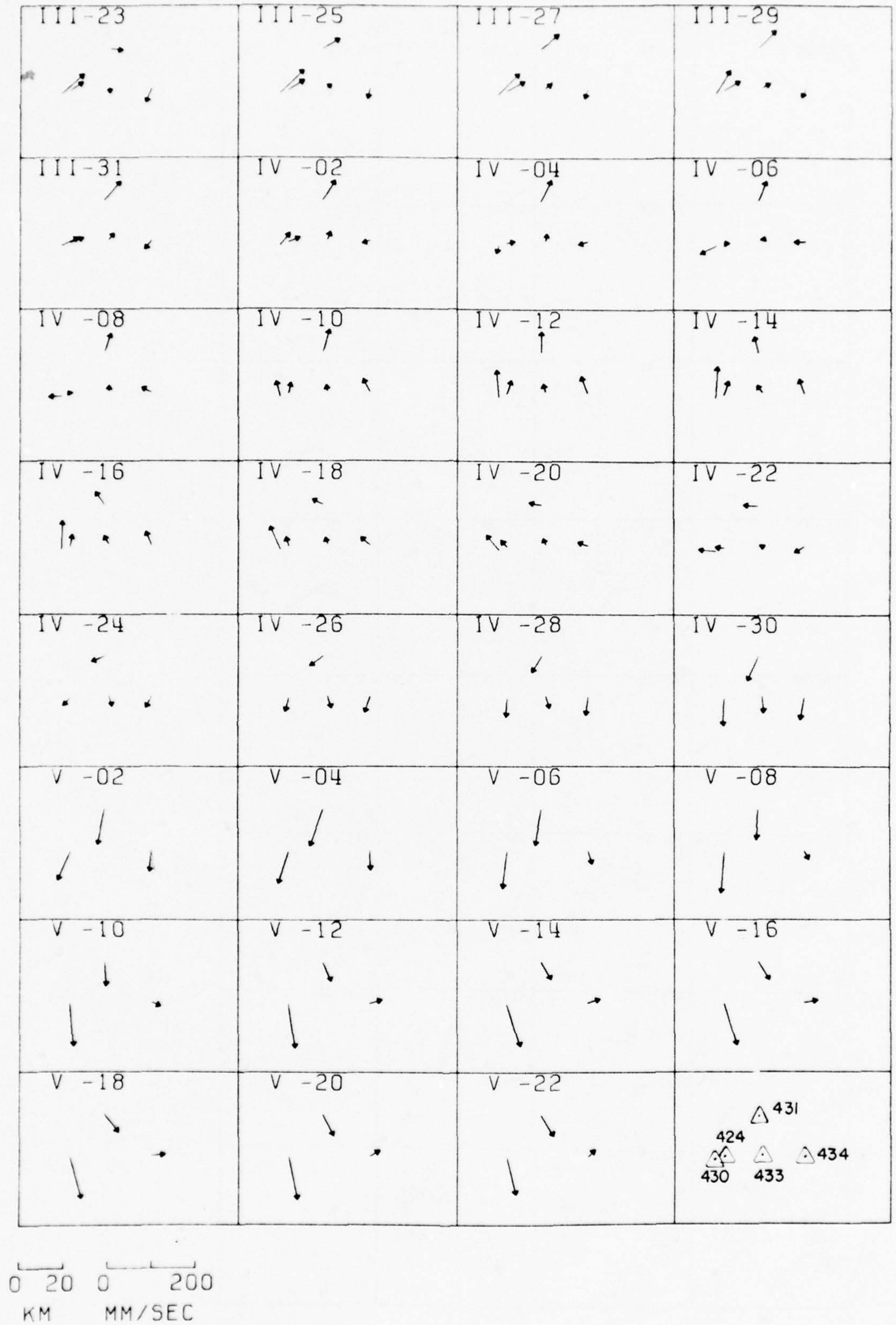
0 20
KM

TEMPERATURE IN DEGREES C

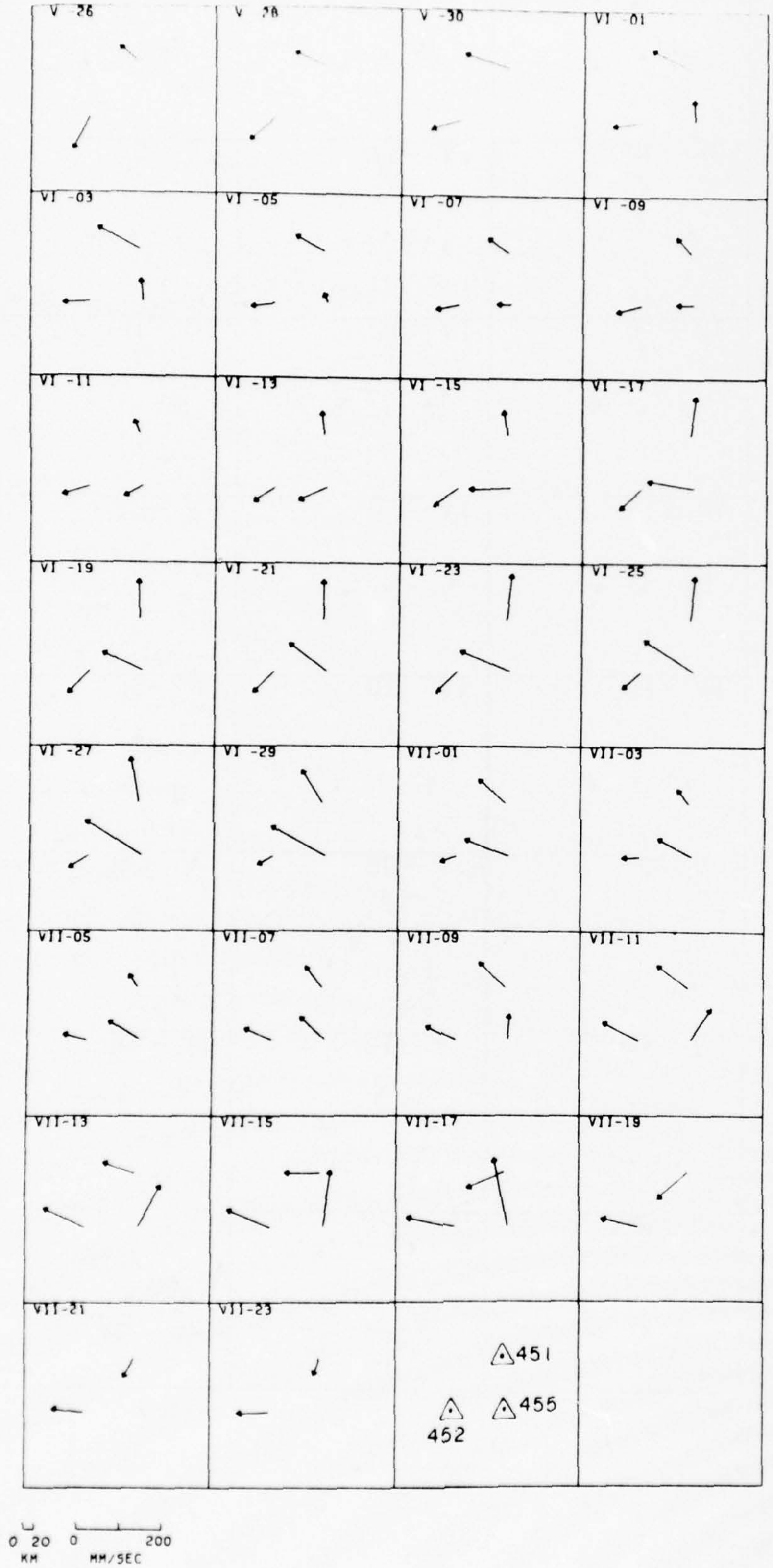
ARRAY 1 4000 M.



ARRAY 2 4000 M.



ARRAY 3 500 M.



V -26
V -28
V -30
VI -01
VI -03
VI -05
VI -07
VI -09
VI -11
VI -13
VI -15
VI -17
VI -19
VI -21
VI -23
VI -25
VI -27
VI -29
VII-01
VII-03
VII-05
VII-07
VII-09
VII-11
VII-13
VII-15
VII-17
VII-19
VII-21
VII-23
451
452
455
0 20
KM
0 200
MM/SEC

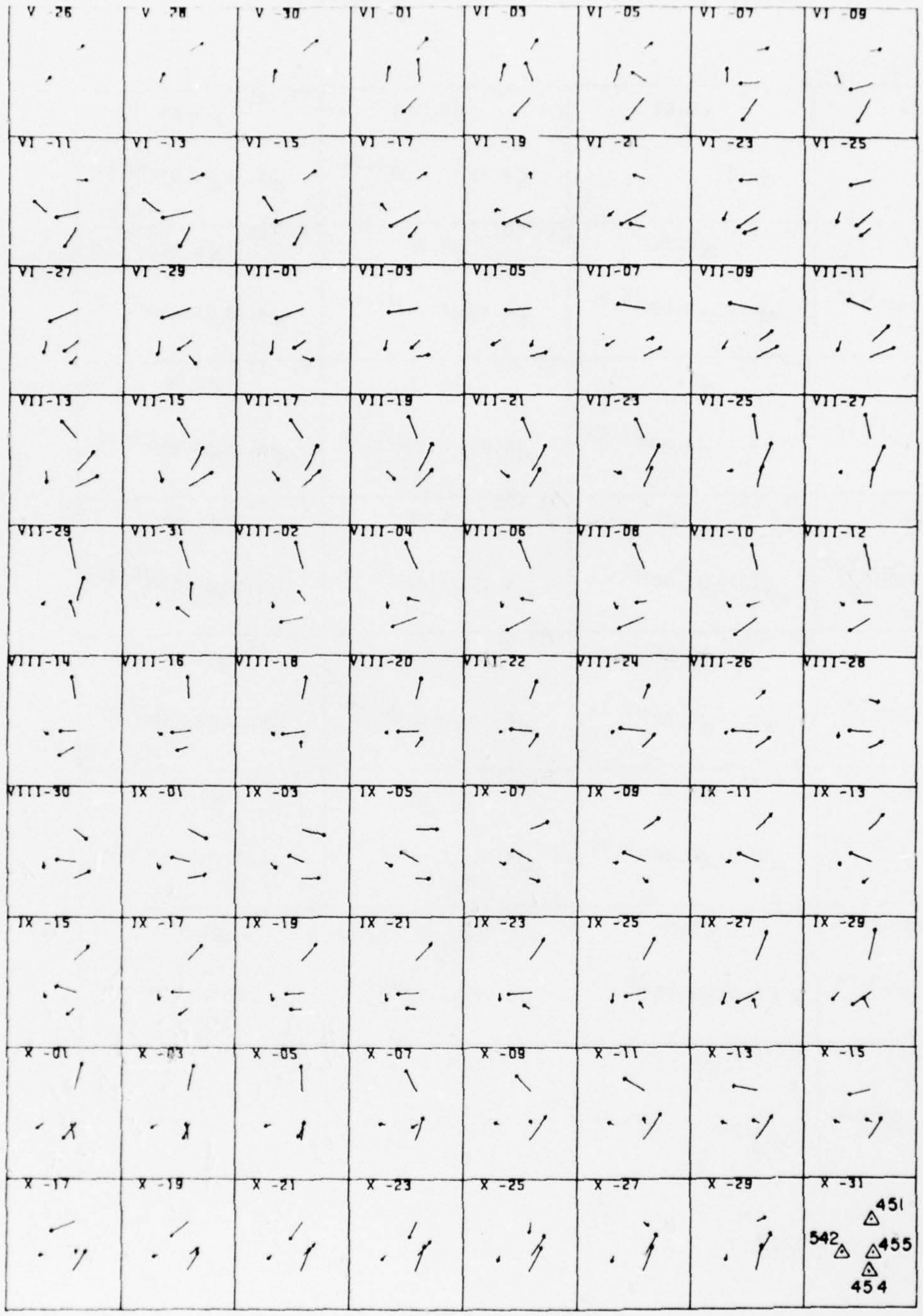
ARRAY 3 500 M.

V -26 16.19 16.29	V -28 16.08 16.27	V -30 16.00 16.22 15.84	VI -01 15.83 16.16 16.02 15.90
VI -03 15.76 16.12 16.09 15.95	VI -05 15.74 16.10 16.08 15.96	VI -07 15.72 16.10 16.07 15.99	VI -09 15.74 16.12 16.13 16.00
VI -11 15.76 16.12 16.10 16.16	VI -13 15.77 16.11 16.06 16.23	VI -15 15.79 16.08 16.02 16.17	VI -17 15.79 16.12 15.98 16.13
VI -19 15.76 16.13 15.94 16.12	VI -21 15.81 16.14 15.98 16.11	VI -23 15.88 16.15 16.02 16.19	VI -25 15.89 16.18 16.07 16.26
VI -27 15.98 16.19 16.12 16.33	VI -29 15.98 16.19 16.22 16.34	VII-01 15.95 16.16 16.16 16.39	VII-03 15.96 16.10 16.15 16.47
VII-05 16.01 16.06 16.12 16.52	VII-07 16.08 16.02 16.08 16.49	VII-09 16.16 16.01 16.09 16.42	VII-11 16.24 16.00 16.15 16.42
VII-13 16.29 15.99 16.19 16.49	VII-15 16.26 15.97 16.28 16.54	VII-17 16.22 15.92 16.31 16.69	VII-19 16.15 15.90 16.71
VII-21 16.11 15.91 16.68	VII-23 16.13 15.86 16.75	451 453 452 455	

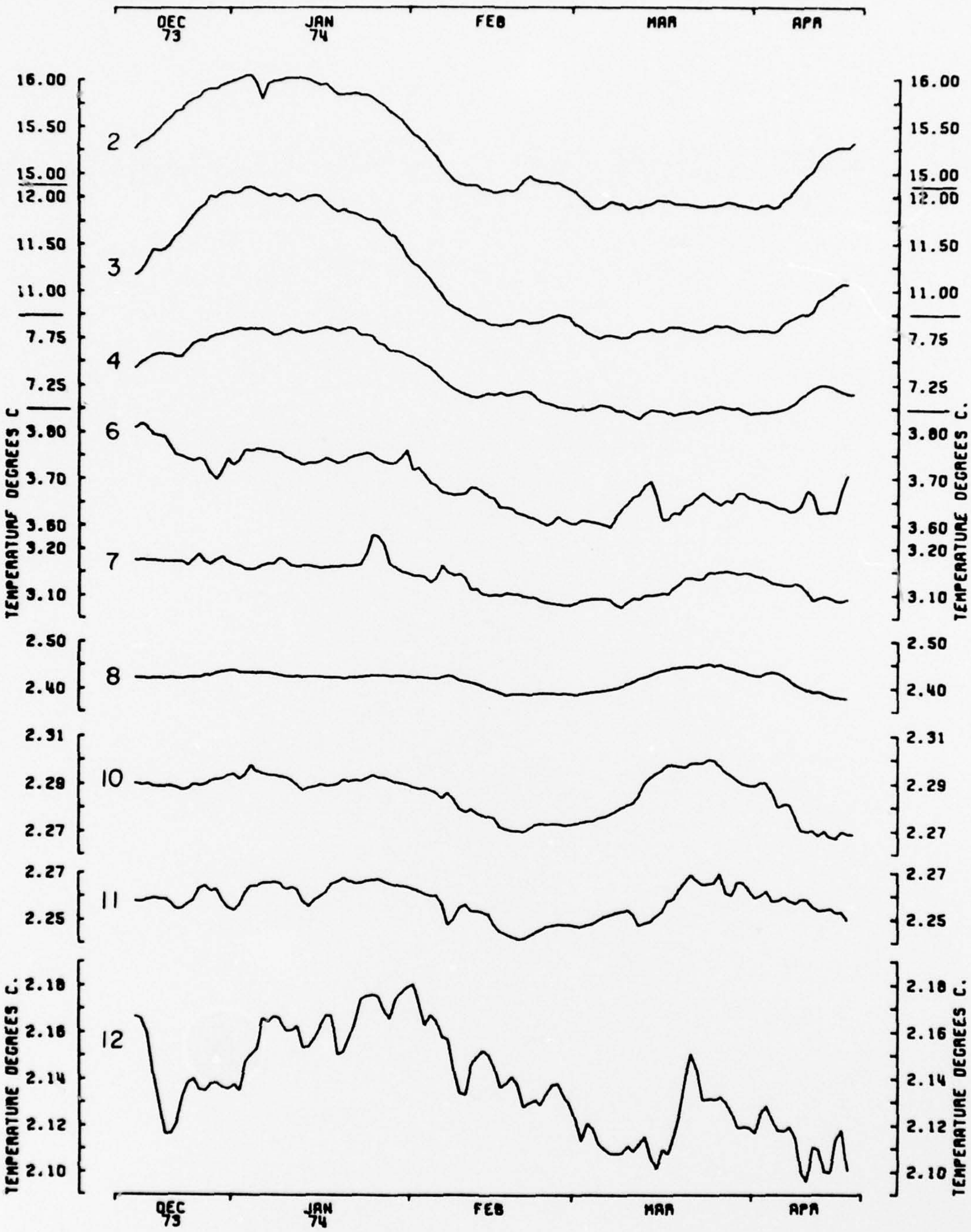
0 20
KM

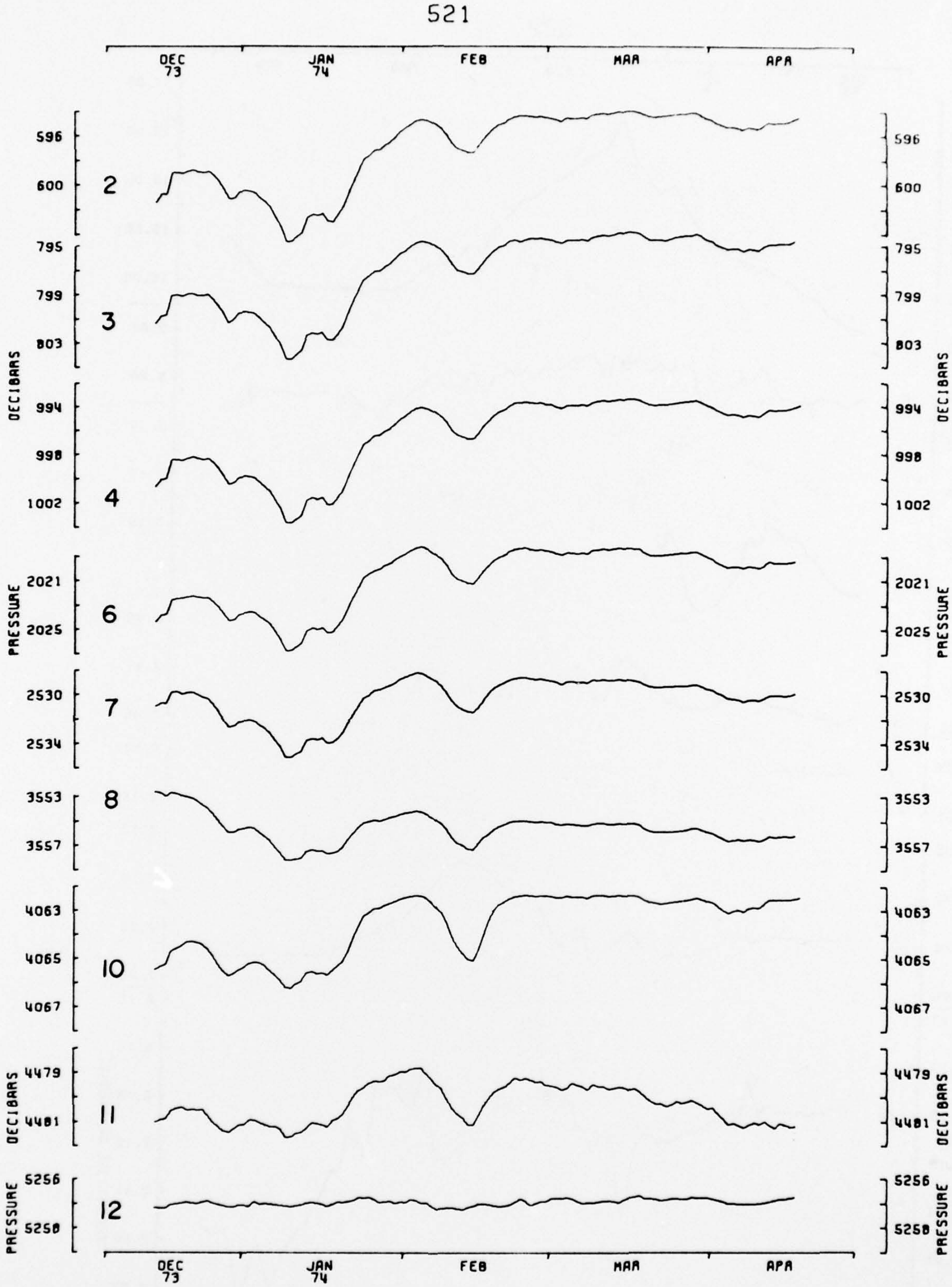
TEMPERATURE IN DEGREES C

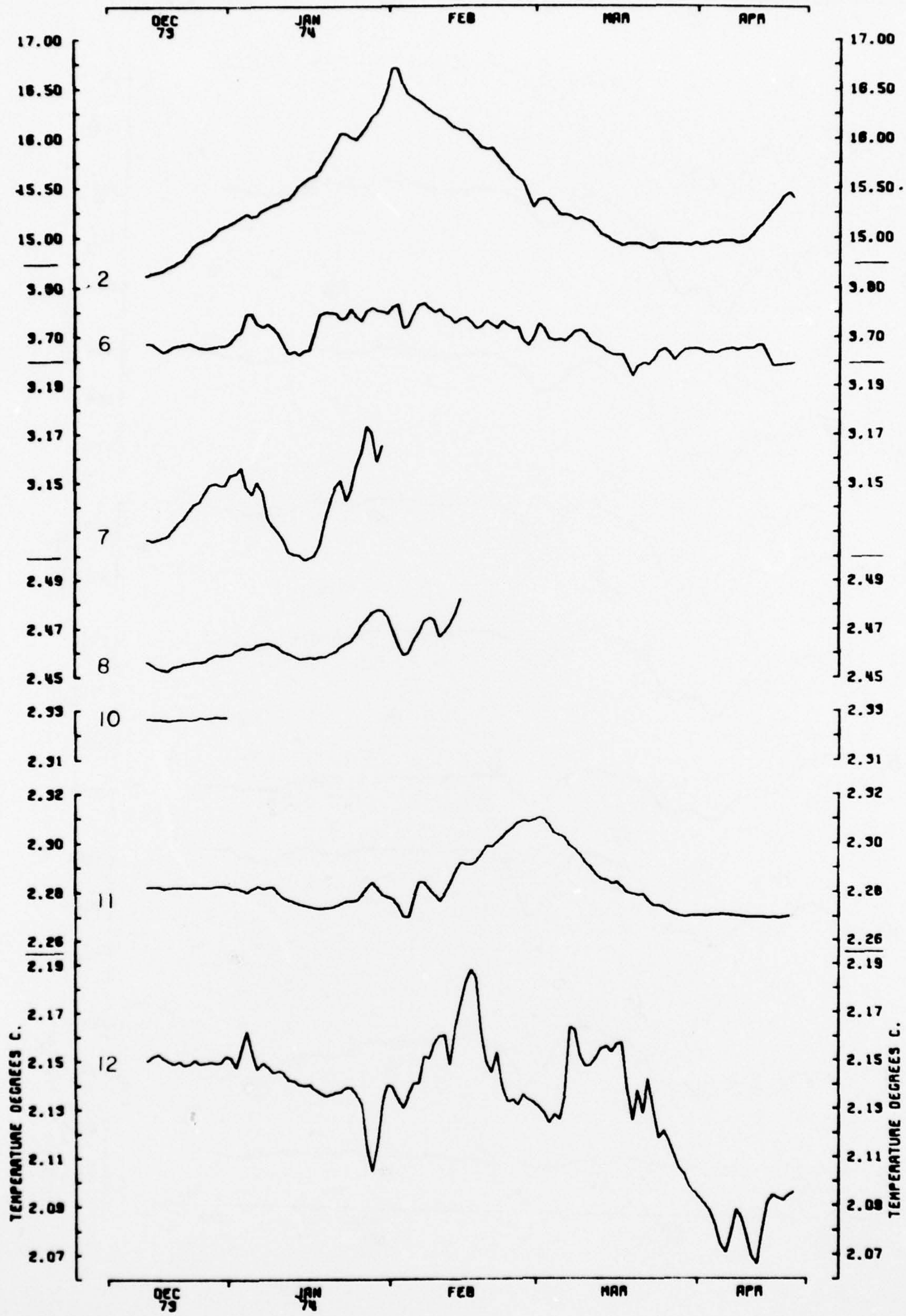
ARRAY 3 4000 M.

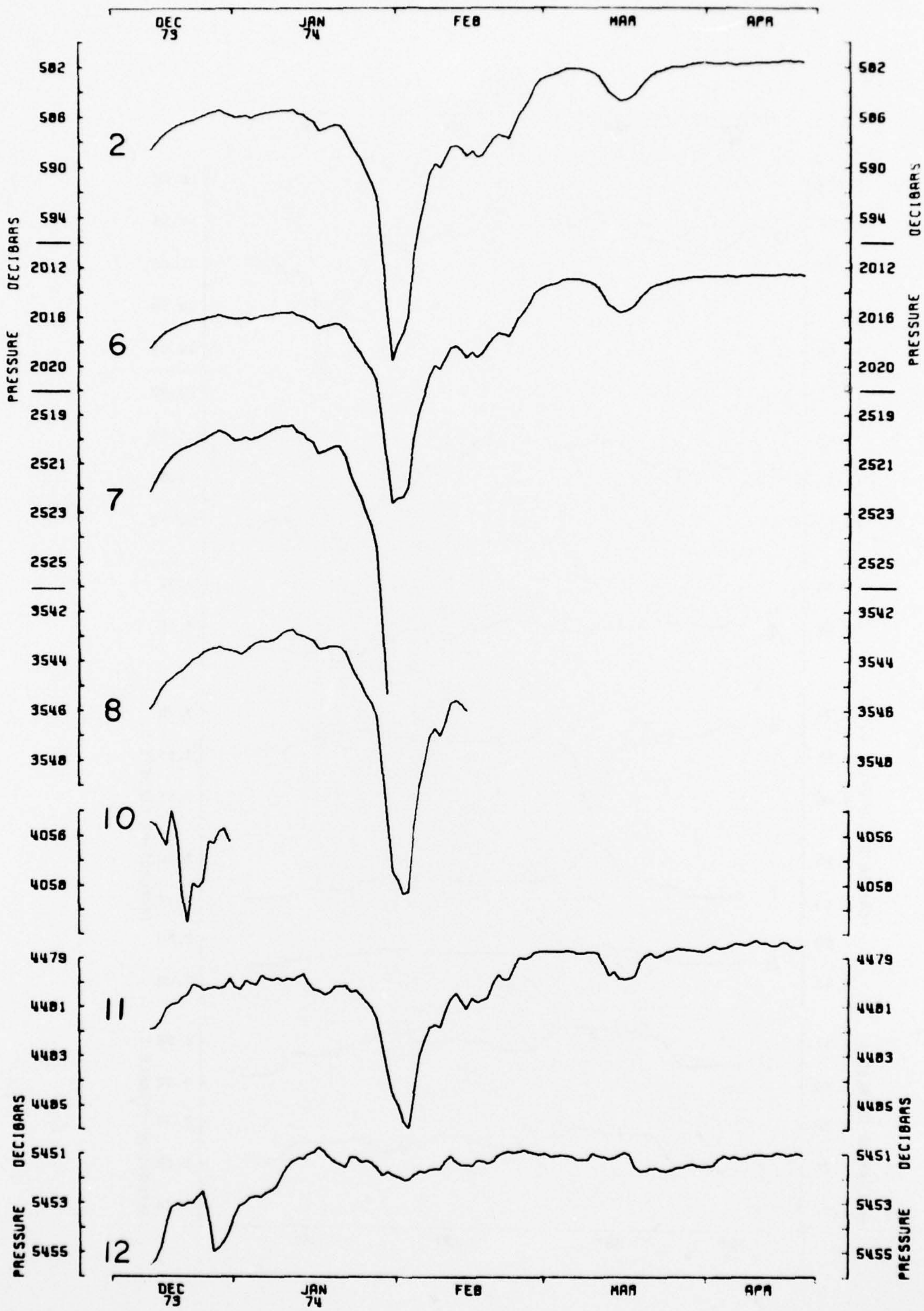


0 200 200
KM MM/SEC

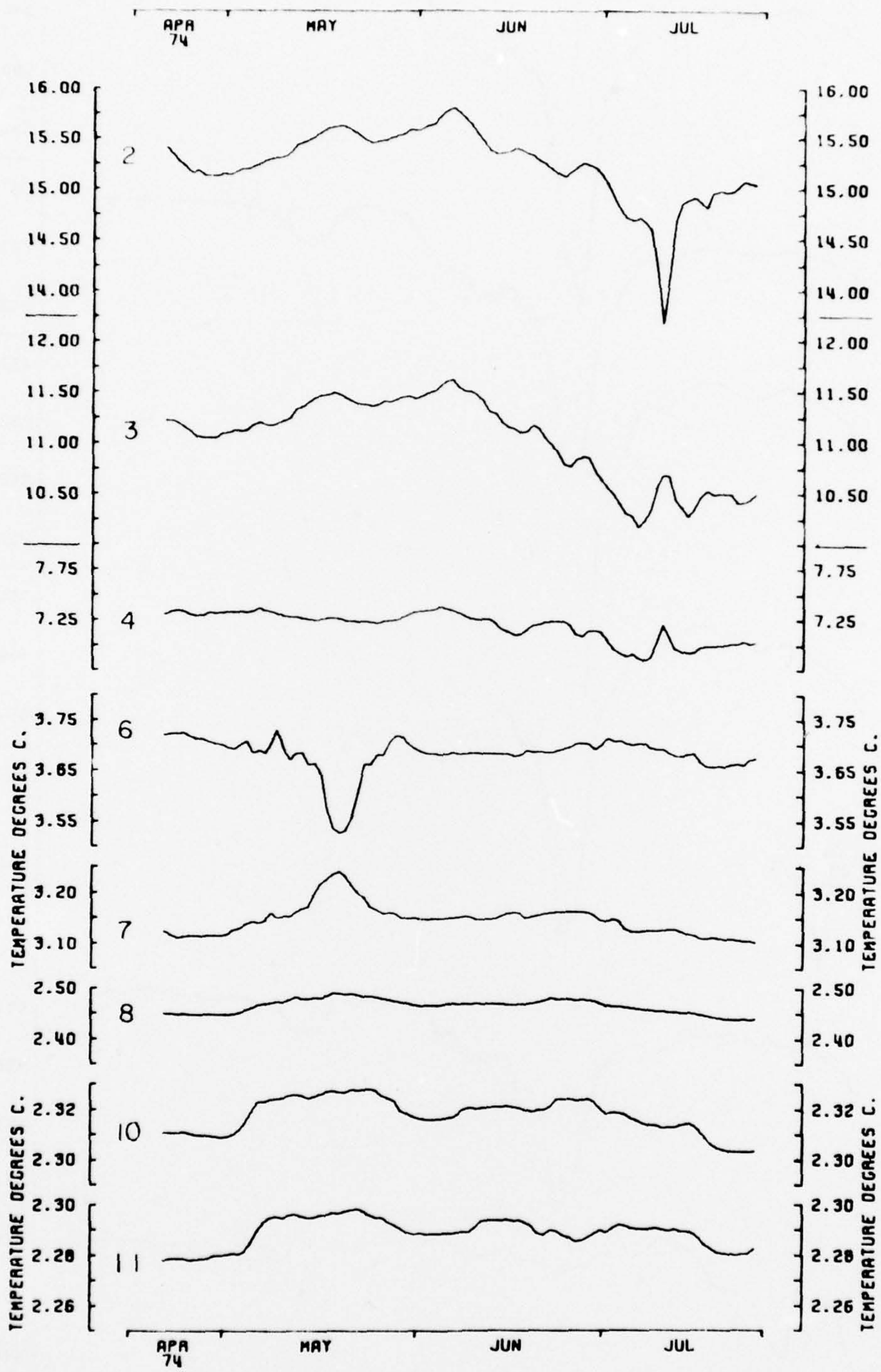

DEC 73
JAN 74
FEB
MAR
APR
16.00
15.50
15.00
12.00
11.50
11.00
7.75
7.25
3.80
3.70
3.60
3.20
3.10
2.50
2.40
2.31
2.29
2.27
2.27
2.25
2.18
2.16
2.14
2.12
2.10
2
3
4
6
7
8
10
11
12
TEMPERATURE DEGREES C.

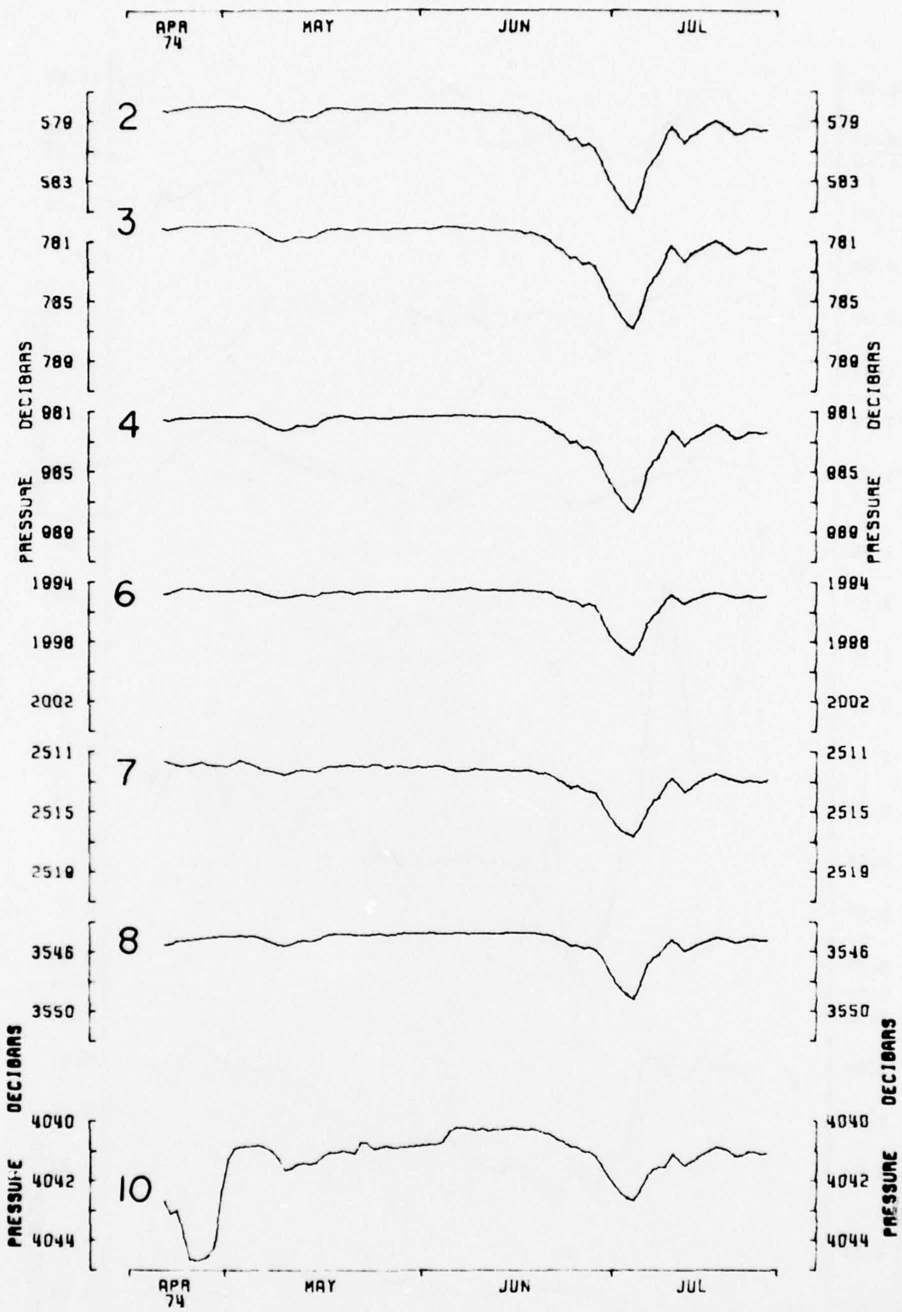

521
DEC 73
JAN 74
FEB
MAR
APR
2
3
4
6
7
8
10
11
12
596
600
795
799
803
994
998
1002
2021
2025
2530
2534
3553
3557
4063
4065
4067
4479
4481
5256
5258
DECIBARS
PRESSURE


DEC 73
JAN 74
FEB
MAR
APR
17.00
16.50
16.00
15.50
15.00
3.80
3.70
3.19
3.17
3.15
2.49
2.47
2.45
2.33
2.31
2.32
2.30
2.28
2.26
2.19
2.17
2.15
2.13
2.11
2.09
2.07
2
6
7
8
10
11
12
TEMPERATURE DEGREES C.

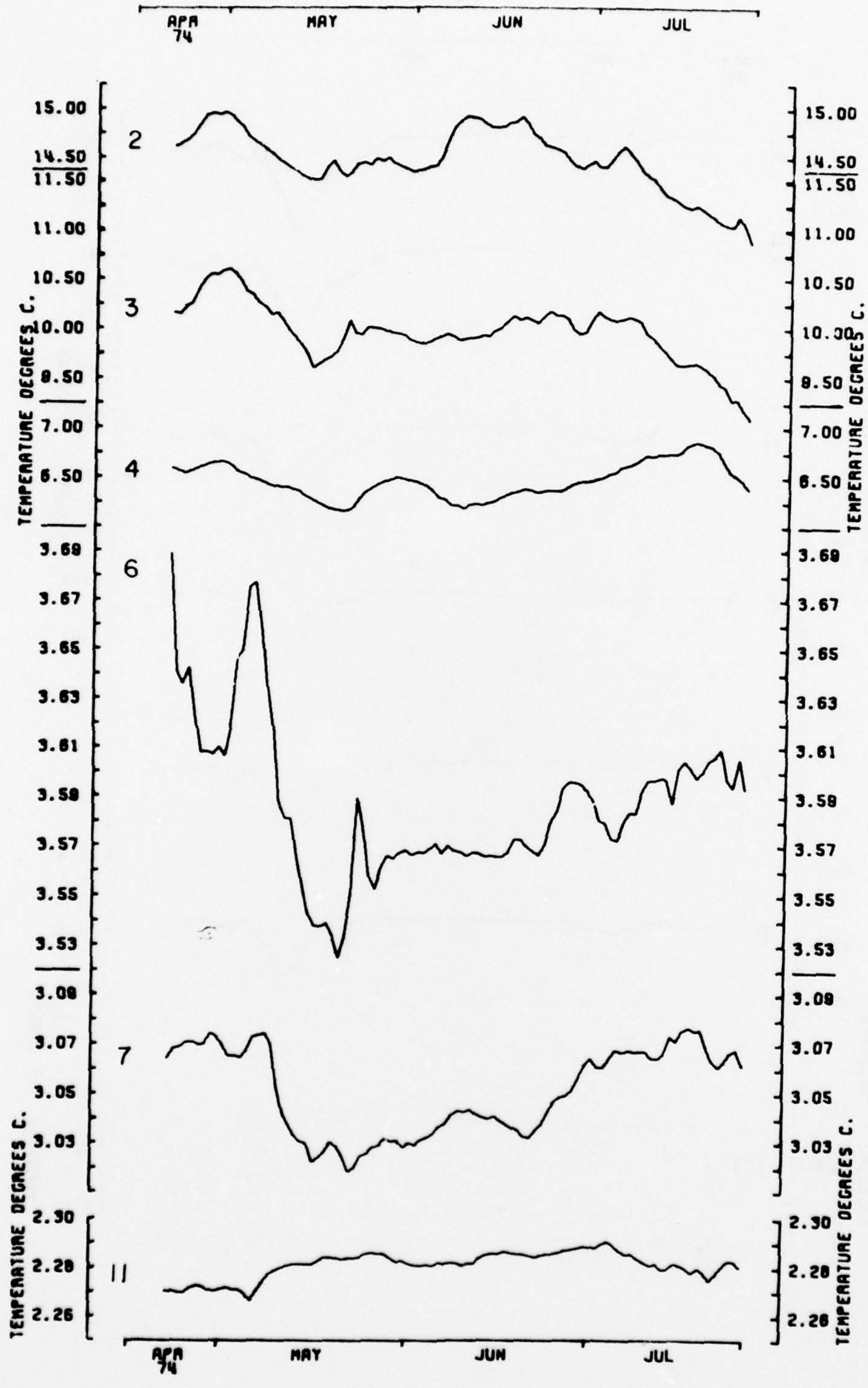


DEC 73
JAN 74
FEB
MAR
APR
PRESSURE DECIBARS
582
586
590
594
2012
2016
2020
2519
2521
2523
2525
3542
3544
3546
3548
4056
4058
4479
4481
4483
4485
5451
5453
5455
2
6
7
8
10
11
12

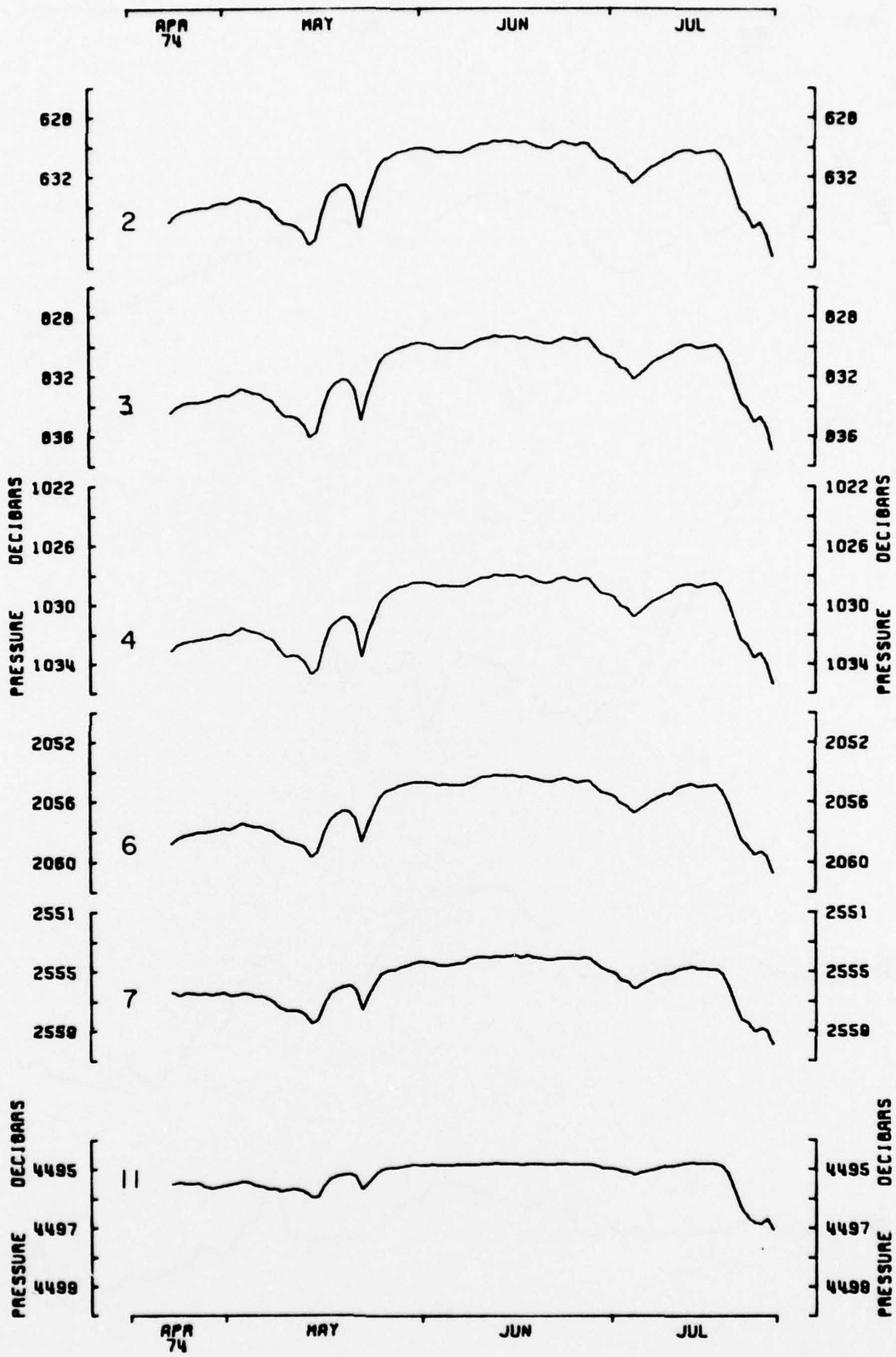

APR 74
MAY
JUN
JUL
16.00
15.50
15.00
14.50
14.00
12.00
11.50
11.00
10.50
7.75
7.25
3.75
3.65
3.55
3.20
3.10
2.50
2.40
2.32
2.30
2.30
2.28
2.26
2
3
4
6
7
8
10
11
TEMPERATURE DEGREES C.

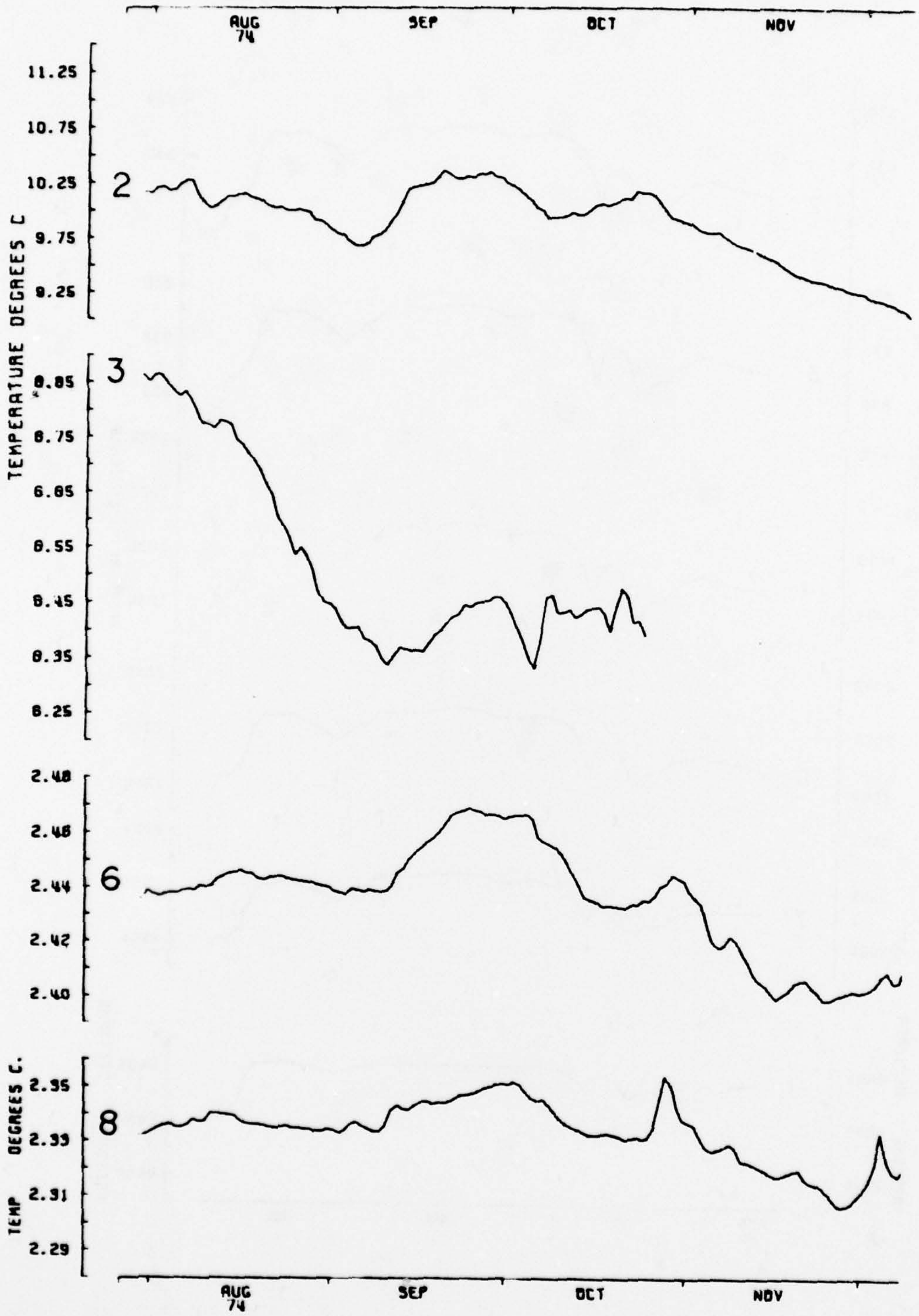


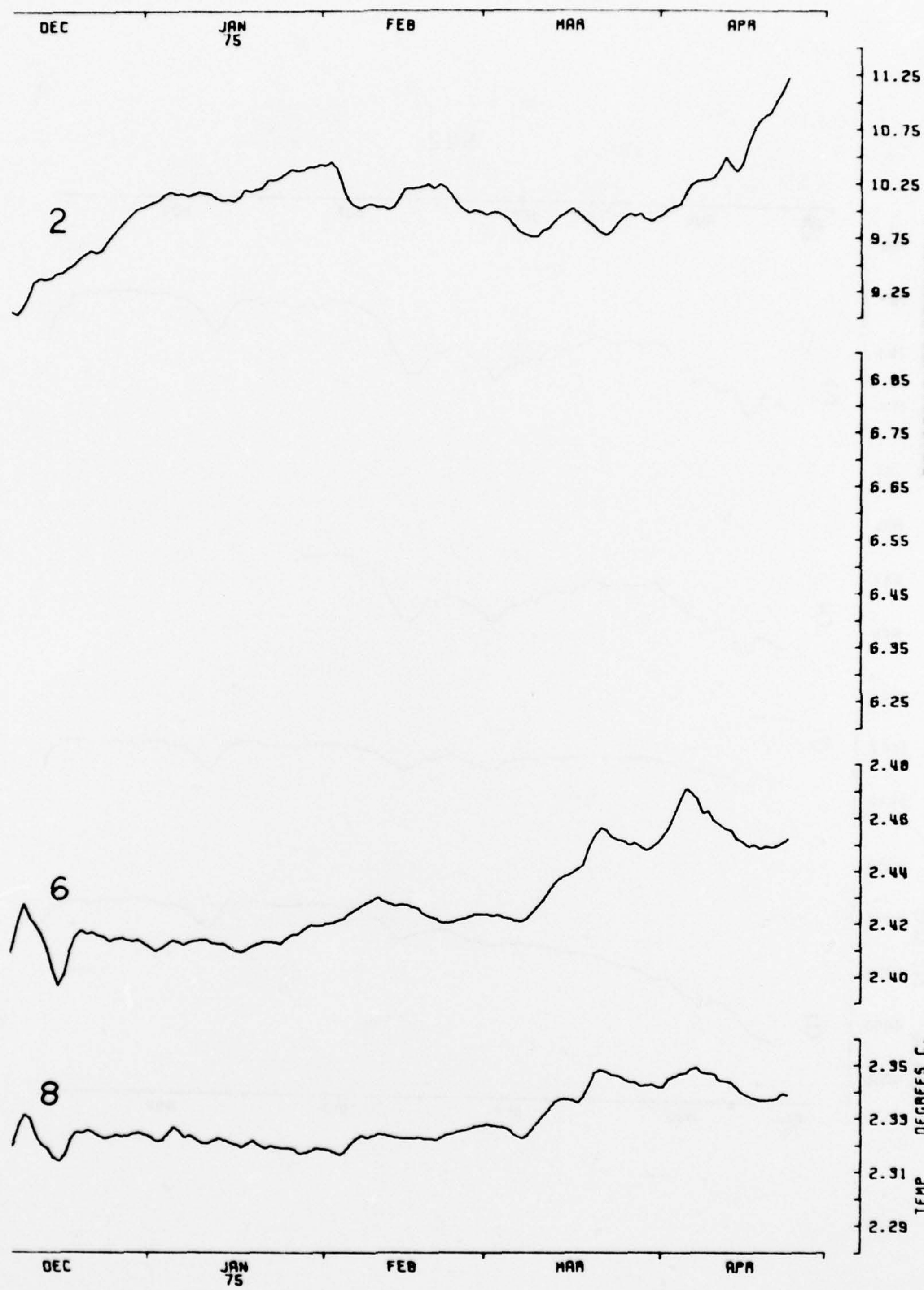
APR
74
MAY
JUN
JUL
2
3
4
6
7
8
10
579
583
781
785
789
981
985
989
1994
1998
2002
2511
2515
2519
3546
3550
4040
4042
4044
PRESSURE DECIBARS

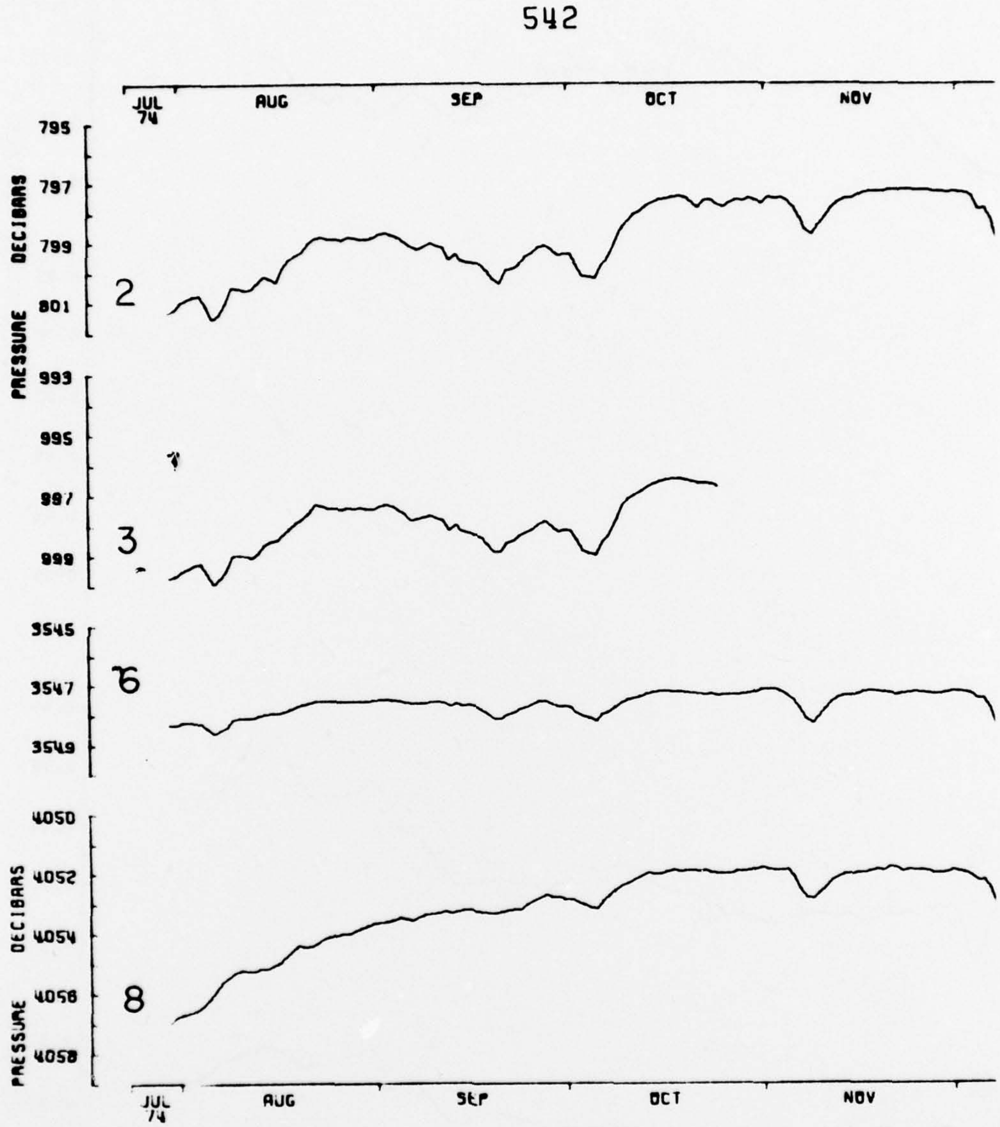

APR 74
MAY
JUN
JUL
15.00
14.50
11.50
11.00
10.50
10.00
9.50
7.00
6.50
3.69
3.67
3.65
3.63
3.61
3.59
3.57
3.55
3.53
3.09
3.07
3.05
3.03
2.30
2.28
2.26
TEMPERATURE DEGREES C.
2
3
4
6
7
11

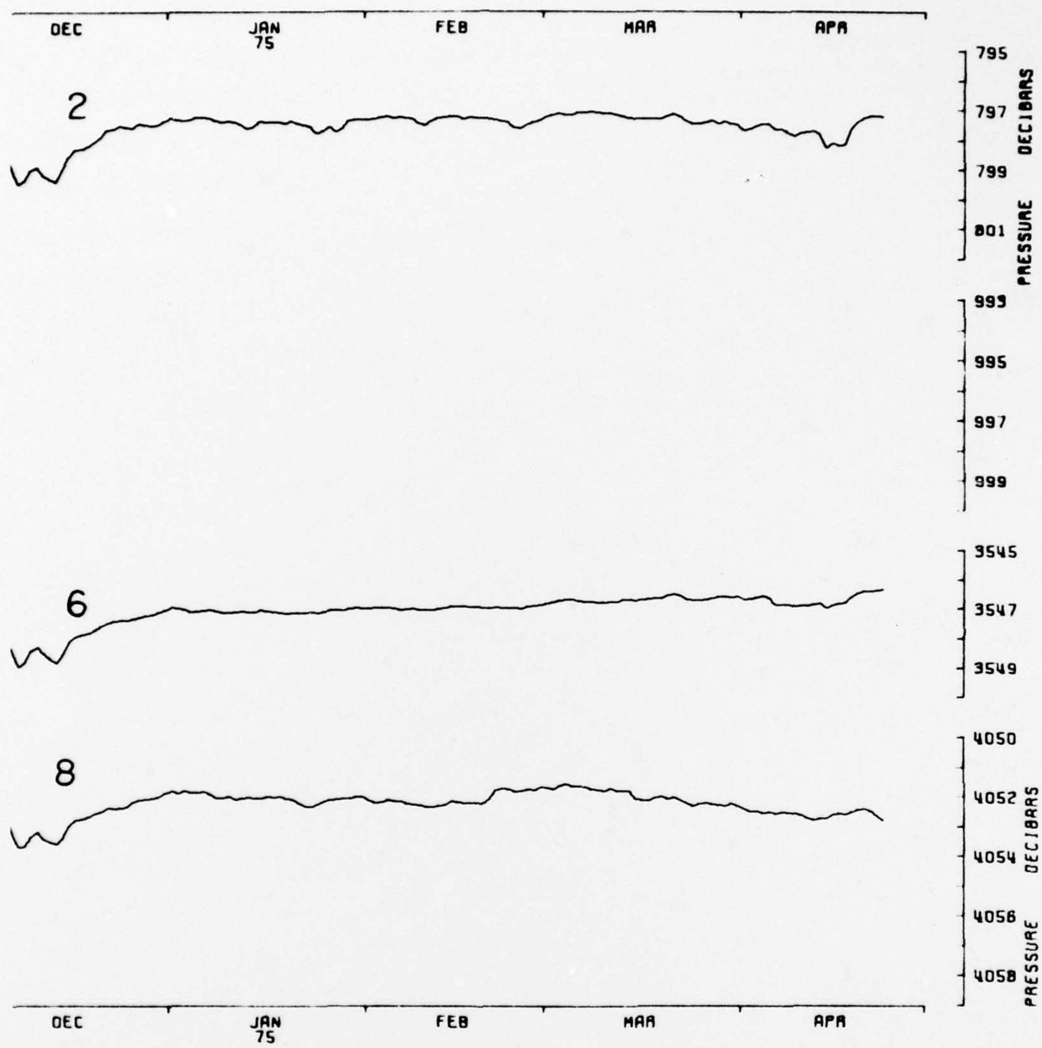
540


APR 74
MAY
JUN
JUL
628
632
2
828
832
836
3
1022
1026
1030
1034
4
PRESSURE DECIBARS
2052
2056
2060
6
2551
2555
2559
7
4495
4497
4499
11
PRESSURE DECIBARS


AUG 74
SEP
OCT
NOV
TEMPERATURE DEGREES C
11.25
10.75
10.25
9.75
9.25
2
3
8.85
8.75
8.65
8.55
8.45
8.35
8.25
2.48
2.46
2.44
2.42
2.40
6
TEMP DEGREES C.
2.35
2.33
2.31
2.29
8
AUG 74
SEP
OCT
NOV


DEC
JAN 75
FEB
MAR
APR
2
6
8
11.25
10.75
10.25
9.75
9.25
6.85
6.75
6.65
6.55
6.45
6.35
6.25
2.48
2.46
2.44
2.42
2.40
2.35
2.33
2.31
2.29
TEMPERATURE DEGREES C
TEMP DEGREES C.


542
JUL 74
AUG
SEP
OCT
NOV
795
797
799
801
PRESSURE DECIBARS
2
993
995
997
999
3
3545
3547
3549
6
4050
4052
4054
4056
4058
8


DEC
JAN
75
FEB
MAR
APR
2
6
8
795
797
799
801
993
995
997
999
3545
3547
3549
4050
4052
4054
4056
4058
PRESSURE DECIBARS
PRESSURE DECIBARS

MANDATORY DISTRIBUTION LIST

FOR UNCLASSIFIED TECHNICAL REPORTS, REPRINTS, & FINAL REPORTS
PUBLISHED BY OCEANOGRAPHIC CONTRACTORS
OF THE OCEAN SCIENCE AND TECHNOLOGY DIVISION
OF THE OFFICE OF NAVAL RESEARCH

(REVISED FEBRUARY 1978)

1 Director of Defense Research
and Engineering
Office of the Secretary of Defense
Washington, D.C. 20301
ATTN: Office Assistant Director
(Research)

Office of Naval Research
Arlington, VA 22217
1 ATTN: (Code 460)
1 ATTN: (Code 102-OS)
6 ATTN: (Code 102IP)
1 ATTN: (Code 200)

1 CDR J. C. Harlett, (USN)
ONR Representative
Woods Hole Oceanographic Inst.
Woods Hole, MA 02543

1 Office of Naval Research
Branch Office
495 Summer Street
Boston, MA 02210

Director
Naval Research Laboratory
Washington, D.C. 20375
6 ATTN: Library, Code 2620

1 National Oceanographic Data
Center
National Oceanic & Atmospheric
Administration
3300 Whitehaven St., N.W.
Washington, D.C. 20235

12 Defense Documentation
Center
Cameron Station
Alexandria, VA 22314

Commander
Naval Oceanographic
Office
Washington, D.C. 20373
1 ATTN: Code 1640
1 ATTN: Code 70

3 NORDA 430
NSTL Station, MS 39529

2 CO NORDA
NSTL Station, MS 39529

Woods Hole Oceanographic Institution
WHOI-78-5

A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975) by Susan Tarbell and Ann Spencer. 50 pages. March 1978. Prepared for the Office of Naval Research under Contracts N00014-66-C-0241; NR 083-004; N00014-74-C-0262; NR 083-004; and N00014-76-C-0197; NR 083-400 and for the National Science Foundation, Office for the International Decade of Ocean Exploration under Grants GX-29054 and OCE75-03962.

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

1. Moorings
2. Ocean Currents
3. Ocean Temperature

I. Tarbell, Susan
II. Spencer, Ann
III. N00014-66-C-0241; NR 083-004
IV. N00014-74-C-0262; NR 083-004
V. N00014-76-C-0197; NR 083-400
VI. GX-29054
VII. OCE75-03962

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
WHOI-78-5

A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975) by Susan Tarbell and Ann Spencer. 50 pages. March 1978. Prepared for the Office of Naval Research under Contracts N00014-66-C-0241; NR 083-004; N00014-74-C-0262; NR 083-004; and N00014-76-C-0197; NR 083-400 and for the National Science Foundation, Office for the International Decade of Ocean Exploration under Grants GX-29054 and OCE75-03962.

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

1. Moorings
2. Ocean Currents
3. Ocean Temperature

I. Tarbell, Susan
II. Spencer, Ann
III. N00014-66-C-0241; NR 083-004
IV. N00014-74-C-0262; NR 083-004
V. N00014-76-C-0197; NR 083-400
VI. GX-29054
VII. OCE75-03962

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
WHOI-78-5

A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975) by Susan Tarbell and Ann Spencer. 50 pages. March 1978. Prepared for the Office of Naval Research under Contracts N00014-66-C-0241; NR 083-004; N00014-74-C-0262; NR 083-004; and N00014-76-C-0197; NR 083-400 and for the National Science Foundation, Office for the International Decade of Ocean Exploration under Grants GX-29054 and OCE75-03962.

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

1. Moorings
2. Ocean Currents
3. Ocean Temperature

I. Tarbell, Susan
II. Spencer, Ann
III. N00014-66-C-0241; NR 083-004
IV. N00014-74-C-0262; NR 083-004
V. N00014-76-C-0197; NR 083-400
VI. GX-29054
VII. OCE75-03962

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
WHOI-78-5

A COMPILATION OF MOORED CURRENT DATA AND ASSOCIATED OBSERVATIONS (MODE-SITE, VOL. XVI 1971-1975) by Susan Tarbell and Ann Spencer. 50 pages. March 1978. Prepared for the Office of Naval Research under Contracts N00014-66-C-0241; NR 083-004; N00014-74-C-0262; NR 083-004; and N00014-76-C-0197; NR 083-400 and for the National Science Foundation, Office for the International Decade of Ocean Exploration under Grants GX-29054 and OCE75-03962.

Current, temperature and pressure measurements from instruments moored in the MODE area during the years 1971-1975 are presented. Record lengths vary from 2 weeks to 7 months. Data from individual instruments are displayed in the form of statistical tables, spectral plots and variables vs. time plots. Current data are additionally displayed as progressive vector plots. Composite plots of temperature, pressure or velocity are included for groups of records which could be combined to show a meaningful spatial or temporal array. Selected CTD data are included and displayed as potential temperature and salinity versus pressure.

1. Moorings
2. Ocean Currents
3. Ocean Temperature

I. Tarbell, Susan
II. Spencer, Ann
III. N00014-66-C-0241; NR 083-004
IV. N00014-74-C-0262; NR 083-004
V. N00014-76-C-0197; NR 083-400
VI. GX-29054
VII. OCE75-03962

This card is UNCLASSIFIED